WHY DO SOME FIRMS PAY MORE THAN THE MARKET WAGE RATE? A CASE STUDY WITH LONGITUDINAL DATA

by

Richard Parsons

A dissertation submitted to the faculty of
The University of Utah
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

Department of Economics

University of Utah

August 2011

The University of Utah Graduate School

STATEMENT OF DISSERTATION APPROVAL

The dissertation of **Richard Parsons**

has been approved by the following supervisory committee members:

David Kiefer	, Chair	**3/15/2011** Date Approved
Thomas Maloney	, Member	**3/28/2011** Date Approved
Norman Waitzman	, Member	**3/28/2011** Date Approved
Peter Philips	, Member	**4/12/2011** Date Approved
Vicki Whiting	, Member	**4/4/2011** Date Approved

and by **Peter Philips** , Chair of

the Department of **Economics**

and by Charles A. Wight, Dean of The Graduate School.

ABSTRACT

This research studies the three main economic theories of wage as they apply to a specific case study using longitudinal panel data. The firm in the case study pays employees above market wage which presents an interesting opportunity to scrutinize the validity of each wage theory. The economic theories associated with the neoclassical school of thought, the institutional school of thought and power relationships are each tested for a fit with the case study data. Relative to the neoclassical theory, the efficiency wage theory and agency theory are tested as these are the elements of neoclassical thought which support wages above market rates.

Two tests are used to evaluate the hypotheses. The first is a formal econometric test of the shirking model of the efficiency wage theory using production and pay data at the factory level. This is made possible because the four factories in the case study have essentially the same cultural and institutional environment, along with shared production technology and similar product output. As such, control is provided for elements other than wage differences between the factories.

The second test is a survey of plant management. The survey provides a view of both what plant management was trying to accomplish with wage policy, and also how effective they felt the pay practices were. In addition to the survey, the culture within the firm is analyzed logically for its connection to pay practices.

This research concludes that for the four factories studied there is no support for the shirking model of the efficiency wage theory or agency theory. As a result the standard neoclassical wage theory cannot explain the above market wage and is called into question, at least as a generalized model. In addition, there is substantial support provided for the institutional theories around wage as well as evidence of the power of the threat of union organizing. The management survey, the logical analysis of firm culture, and the comparisons to the organizational behavioral research all support the findings that institutional factors heavily influence wages in the sample firm.

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

Wages are a keystone of economic theory; thus understanding the wage mechanism is critical for both economic and business policy. Wages are important for both the economy and for the individual. For the economy, wages provide a key input helping determine the level of employment, a division of income between capital and labor, a source of aggregate demand and an element of public and company policy. For the individual, wages provide a means of sustenance, a social recognition of an individual's contribution, and serve as a building block of an individual's sense of self worth. This research will review the major theories of economic wage applied to a specific set of longitudinal data. These data are for four substantially similar production plants owned by Mars, Incorporated over a 10-year period. This specific situation is of interest because at all four sites wages are paid above the local market wage rate leading to the question: Why do some firms pay more than the market wage rate? Three connected hypotheses will be tested:

Null Hypothesis One: The neoclassical wage theory accounts for the wage policy at these four plants for the study period.

Null Hypothesis Two: The institutional wage theories account for the wage policy at these four plants for the study period.

Null Hypothesis Three: The power relationship wage theories account for the wage policy at these four plants for the study period.

The alternative hypothesis in each case is that the given wage theory does not account for the wage policy at the four plants for the study period.

A widespread dispersion of wages paid, both vertical and horizontal, is well documented throughout industrial countries (Guttschalk & Smeeding, 1997). For example, in July of 2008 management professionals in the United States earned an average wage of $43.60 per hour, while fast food counter workers earned an average of $9.04 (Bureau of Labor Statistics, May 2008). Actors and athletes can earn millions while others make a minimum wage, sometimes even less. This vertical wage variability is a reality in modern societies. Suggested reasons for the variability include different values of human capital, different training and skills, and of course a commonly heard explanation, supply and demand.

Neoclassical wage theory suggests that workers doing the same job, even in different companies, would be paid the same wage. In this research the variability in wage in the same job will be called horizontal wage variance. The forces of competition should press wages and production processes into equivalent efficiency. Equilibrium should be achieved as wage adjustments cause employees to move between companies until wages for the same jobs are in balance. While the vertical wage difference between the management professional and the fast food counter worker is reasonable to many people, it might be surprising to them to find that counter to neoclassical wage theory, the same job in the same city is often paid very different wages.

As one example, Table 1.1 shows that in Chicago for May 2008 procurement clerks earned the following wages by percentile (Bureau of Labor Statistics, May 2008). The top 10% of these workers earn over two times the amount those paid in the bottom 10% earn.

This research will study production plant workers. An example for production plant workers from the same wage survey is shown in Table 1.2 for Chicago team assemblers. Again the top 10% of these workers earn over two times the amount paid to those in the bottom 10%.

These examples from Chicago are repeated ubiquitously (Guttschalk & Smeeding, 1997). Further analysis will reveal that this wage variability is not accounted for by training, or by marginal productivity, or by any of the standard neoclassical supply and demand determinates in the labor market (Uusitab, 2002; Lal, 1979).

Table 1.1 Chicago Procurement Clerk Wages 2008

Bottom 10%	Bottom 25%	Median	Top 25%	Top 10%
11.54	14.12	17.31	20.68	24.51

Table 1.2 Chicago Production Plant Workers 2008

Bottom 10%	Bottom 25%	Median	Top 25%	Top 10%
7.74	8.32	10.69	14.26	18.40

The question that arises from the empirical data is "**Why do some firms pay their employees more than the market wage?**" Several theories have been offered as possible explanations of this phenomenon. This dissertation will employ longitudinal data to test these major wage theories through the use of microeconomic data and management surveys for a single firm operating in multiple geographies.

1.1 Wage Theory

Modern economic wage theories can be found in three general schools of economic thought: neoclassical, institutional, and power relationships. Each of these theories will be briefly described in this introduction and then further developed in Chapter 2.

1.1.1 Neoclassical Theory of Wage

The neoclassical wage theory is derived from a concept of supply of, and demand for labor. Supply of labor is based on an individual's utility function in which consumption and leisure are traded off to maximize utility. "The properties of the supply of individual labor result from the combination of substitution effect and income effect. The combination of these effects seemingly leads to a non-monotonic relation between wages and the individual supply of labor" (Cahuc & Zylberberg, 2004, p. 9). The demand for labor is seen in a wider context. Labor is one of the factors of production. A firm chooses the combination of inputs, including labor, that minimizes its cost of production for the profit maximizing output quantity. Given supply of labor and demand for labor, wages are then determined as the price that brings these two forces into equilibrium. The key results from the neoclassical theory of wage determination include, for a competitive environment:

- Homogeneous workers and jobs will receive equal wages.
- Workers who are unemployed choose to be unemployed as they maximize their utility trading off between work and leisure. These voluntarily unemployed workers prefer leisure to the disagreeability of work at the available wage.
- Workers would move quickly and easily between competing jobs when small differences in wage rates and job characteristics appear.

The reality of labor markets undermines these expected results. The dispersion of wages was demonstrated in Table 1.1 and Table 1.2 and researched by Guttschalk (1997). Also, involuntary unemployment is a reality across the globe and has been studied in detail since the great depression. And finally workers do not move quickly between jobs over small wage differences (Moscarini & Thomsson, 2007).

These empirical realities have spawned a variety of adjustments to neoclassical wage theory. According to Krueger and Summers (1988) there are two types of answers to the question of why some firms pay more for the same job. First, firms may not be profit maximizers, but rather act according to the manager or owners' alternative agenda. This is called an *agency theory* mechanism. Agency theory is often expressed as a manager maximizing their own personal welfare rather than that of the firm and its owners. The second type of answer is based on the idea that firms may, for different reasons, find it unprofitable to reduce wages to market level. These are *efficiency wage* considerations. Both of these answers however are focused within the rational world of homo economicus and orthodox neoclassical theory. Because these theories form an important part of the empirical work of this research they will be discussed in more detail in Chapter 2.

1.1.2 Institutional and Social Determination Wage Theory

Other economists have developed theories basing wage determination as a function of social institutions and cultural/psychological determinates. These ideas began with Veblen's anthropological economic work.

> Wages is a fact incident to the relation of employer and employed. It is, in the sense fixed by colloquial use…. The laborer, from the point of view of consumption of products, is no longer "laborer": he is a member of society simply, and his share of the product of industry is the share of an individual member of society. (Veblen, 2002, p. 20)

Veblen tells us that wages are set by social and historical standards and with views of equity and reciprocity rather than supply and demand.

A key article by Akerlof (1982) brought the idea of fair wage and fair effort back from anthropology to economics. According to Akerlof the employer pays a wage higher than the going rate and the employee in return exceeds the market work standards. These are seen as a sequence of gifts and counter gifts as would also be seen in primitive social organizations. Cahuc and Zylberberg (2004) provide a relationship showing that social norms influence productivity and effort at equilibrium. While there are few universal behaviors that can be expected from this theory, as social norms will vary by group and over time, the identified institutions and social norms for a specific situation can be thought to drive wage relationships in a logical way and the specific institutions such as unionism and bureaucratic hiring rules can be studied for impact. The impact of institutions and social behaviors have also been studied and documented in work with game theory and primitive cultures.

1.1.3 Power Relationships Wage Theory

A final theory of wage setting is centered around the power relationship between worker and employer. In certain forms this theory can be traced to the "Father of Economics," Adam Smith. In speaking of labor and wages and the dispute between employer and employee, he says, "*It is not, however, difficult to foresee which of the two parties must, upon all ordinary occasions, have the advantage in the dispute, and force the other into compliance with their terms*" (Smith, 1981 (1776)). The words "force" and "dispute" are not synonymous with the concepts of an open free market.

Perhaps best known in this arena is the significant work that has developed around Marx's theory of social struggle and surplus value. Marx (1844) states "wages are determined through the antagonistic struggle between capitalist and worker" (para. 1). Marx notes that the wage actually paid a given worker may be temporarily above or below the normal wage. Supply and demand forces cause oscillations above and below a "certain mean." The mean is the "natural price . . . determined independently of demand and supply" (Marx, 1891, para 5).

While Marx's theory of wages started with the view that capitalism would drive wages to a subsistence level, he asserted that the average wage is "that quantum of the means of nourishment which is absolutely requisite to keep the laborer in bare existence as a laborer," (Marx, 1848, para 22). Subsequently he began to add additional items of historical or cultural need to the definition of subsistence.

> In 1865, during his address to the General Council of the First International, Marx presented his fully developed theory of wages. There is still a minimum limit on wages that is basically a physiological minimum but there is no maximum. The determination of where a given wage will lie … is based on the respective powers of the combatants. This seems very similar to the class struggle Marx details in the Communist Manifesto. (Bigelow, 1999, Para. 5)

In Marx's world the power struggle between the capitalist and the worker over the produced surplus value is reflected through the wage.

Another area of research that fits into the power struggle group of wage theories is the work around union bargaining. A large amount of empirical and theoretical work has been developed around union negotiation. Despite the decline in union membership, union bargaining is both historically and currently very important to the world of wage setting. While union density has decreased, collective bargaining coverage is still quite high because in most European countries collective agreements prohibit differentiating between union and nonunion employees. According to the OEDC (1997) union density for member countries is 44% but collective bargaining is 68% (Cahuc & Zylberberg, 2004).

Bargaining theory can be traced to Edgeworth (1881) where parties divide goods in a pareto optimal way, and then continues with Nash (1951) and Stahl (1973) and Rubinstein (1982) where game theory was first explored. If the rules of the game (utility preferences of the players and alternative options) can be described, a best case equilibrium can be modeled. Bargaining theory has resulted in many modern economic models. Models around bargaining have been created and incorporated into economic theory. They include the monopoly union model, markup and union power model and insider/outsider model. These models can result in efficient outcomes under certain assumptions (Cahuc & Zylberberg, 2004). Empirical studies suggest that unions do in fact increase wages (Cahuc & Zylberberg, 2004).

Figure 1.1 shows a graphic outline of the three wage theories discussed and the areas where these intersect. Each of these theories will be discussed in detail in Chapter 2.

1.2 Setting Up the Test

The test in this research will employ both case study and econometric approaches to determine which of the theories being tested fit with the data. The theories tested include the neoclassical (efficiency wage, agency), institutional determination and power relationships. Efficiency wage will be tested directly using statistical regression analysis to determine if productivity is related to wage premium. The other theories will be tested through the use of a management survey and aligning each theory's stylized facts with the empirical evidence based upon the test firm's specific culture, history and institutional arrangements.

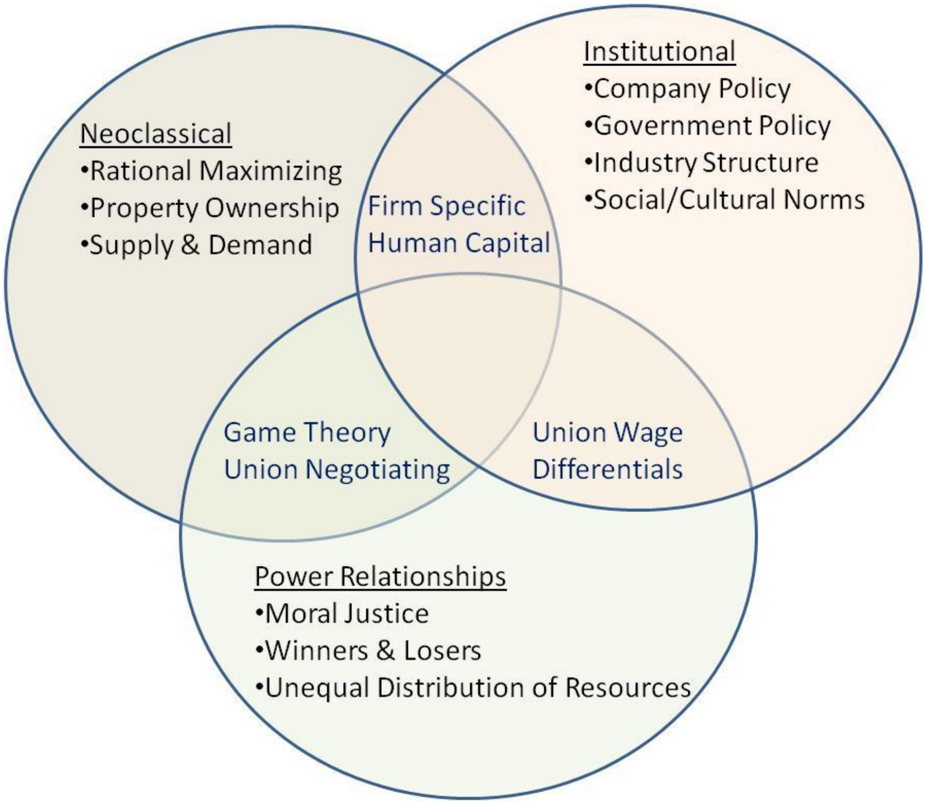


Figure 1.1 Model of Wage Theories

Contributions of this research will include a direct productivity test of the efficiency wage proposition. While the literature is rich in terms of theoretical discussions of efficiency wage and its implications, the empirical work published to date is either at a macro level, with non-US data, with verifiable results or with proxies for productivity such as the level of supervision. Examples of these are addressed in Chapter 2. Production line data sufficient to model total factor productivity by factor (resulting in labor productivity) are rare and this researcher has not found a case where it has been used in empirical work associated with efficiency wage theory. In addition to the econometric work relating productivity to wage, a management survey will be used to test all the wage theories. The survey will provide insight into the motives and results of management practice relating to agency, institutional and power relationship theory, and also will provide backup and support to the econometrics regarding the efficiency wage test. The management personnel that set wage policy at each plant will be the population for this survey. These individuals were responsible for hiring, firing and achieving output objectives. They studied the information available on wages for their site and made the recommendations on wage rates. They also lived with the results of the implemented wage policy.

This research will also provide new information and insights associated with the question of "why some firms pay more than the market wage rate," as it explores management policy and practices regarding the various theories on wage determination. In addition, this research will align the economic wage theory with the latest in terms of management theory on motivation, finding additional empirical support for some economic theories and discrediting others.

2. LITERATURE REVIEW

2.1 Efficiency Wage Theory Literature Review

Efficiency wage theory is founded on the idea that it can be profit maximizing for a firm to pay workers a higher wage than the going market rate. This theory means that a firm's production costs are actually reduced by paying a higher wage. In its most common model efficiency wage theory suggests that all other things being equal, effort is a function of wage, and that output is a function of effort. The generally assumed shape for the effort curve is an S shaped curve (Stiglitz, 1976). At the low end of wage, little effort is expended. As wages increase $E' > 0$ and effort increases rapidly in response to premium wages. However, a point is reached where $E'' < 0$. Here either the income effect of the high wage takes over, or the ability of the worker to increase effort diminishes. Eventually effort is either flat or declines. The Output resulting from the effort is assumed to have a monotonic

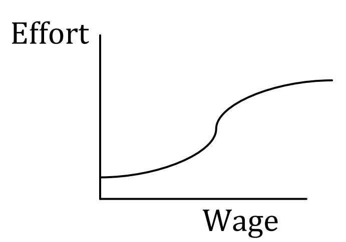


Figure 2.1 Wage and Effort Relationship

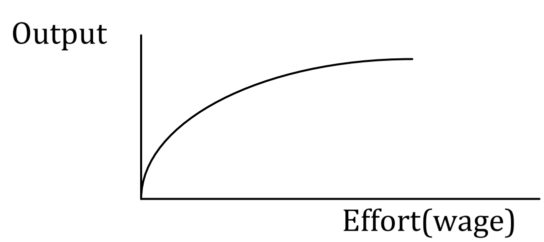


Figure 2.2 Effort and Output Relationship

functional relationship and diminishing returns with respect to wage as long as additional effort results in some increased output $\frac{dO}{dE} > 0$.

2.1.1 History

Efficiency wage theory came out of early work on economic development in less developed countries where the links between wages, nutrition and health were hypothesized. Bliss and Stern (1978) and Leibenstein (1957) present empirical evidence that increases in the nutrition of workers can sufficiently increase the productivity of those workers to outweigh the cost to the employer of the higher payment to workers (Weiss, 1990).

Based on this "wage to health hypothesis" and related microfoundations, efficiency wage theory emerged as a microeconomic explanation of real world phenomena that was not appropriately explained with existing theory. Since the time of the great depression and the General Theory, macroeconomics has been focused on the causes and reasons for involuntary unemployment and “sticky” wages. But why are wages sticky? Solow in 1979 described a mathematical model where the optimized wage was required to satisfy a condition such that the elasticity of effort with respect to the wage is unity. This mathematical model is called the Solow condition and the optimized wage was called the efficiency wage (Solow, 1979). In addition to sticky wages, further labor market phenomena which needed explanation included both the dual labor market and wage distribution variability for identical workers. With simple extensions, the efficiency wage models could be made to explain these stylized facts as well. The dual labor market can be explained by finding some sectors where the efficiency wage model applies resulting in higher wages and involuntary unemployment, and some sectors where it does not apply allowing for the standard neoclassical results. Wage distribution can also be explained by having firms with different effort productivity relationships. Also of interest during this research certain conditions were identified which allow for a high road – low road result to be found within the same effort productivity relationship (see Appendix E for this insight and a possible future study).

2.1.2 Kinds of Models

A proliferation of models occurred in the early 1980s with publications by Stigliz and Shapiro (1984), Salop (1979), Malcomson (1981) and Akerlof (1982) among others. Under the heading of efficiency wage theory, four model groupings have been created in this research to present the literature used to explain why some firms may pay more than the minimum pay needed to attract employees.

1. They are paid the premium wage in order to minimize turnover costs. If firms must bear part of the costs of turnover (search and training), and if turnover is a decreasing function of the wages firms pay, there may be an incentive to raise wages in order to minimize turnover cost (Salop, 1979).
2. Increasing wages raises workers' effort level (shirking model). Workers who are paid only the equivalent wages of jobs on the outside have little incentive to perform well, since losing their jobs would not be costly. By raising wages, firms may make the cost of job loss larger and thereby encourage good performance (Stiglitz & Shapiro, 1984).

3. Workers' feelings of loyalty to their firm increase with the extent to which the firm shares its profits with them. These feelings of loyalty may have a direct effect on productivity (Akerlof, 1982).

4. Firms which pay higher wages will find that they attract a higher quality pool of applicants. If worker quality is not directly observable, this will be desirable (Malcomson, 1981).

The theorized stylized facts for the efficiency wage model would generally include the following:

1. Pay lower the first year – future increases are an incentive to avoid shirking.
2. Constantly pay above the market rate in each year.
3. Achieve the labor effort necessary to create above market labor productivity.
4. Lower amounts of supervision can be utilized.
5. Productive surplus is generated which can be shared between higher wages and profits.

2.1.3 The Solow Condition

Derivation of the Solow Condition:

Under efficiency wage theory a firm's output is given by $f(e(w)L)$

A firm's costs is given by wL

A firm's profit is given by $\pi = f(e(w)L) - wL$

This will be optimized by taking the first order conditions for *w* and *L* and setting them to zero :

$$\frac{d\pi}{dw} = 0 = f'(e(w)L) \cdot e'(w)L - L$$

$$\frac{d\pi}{dL} = 0 = f'(e(w)L) \cdot e(w) - w$$

solving for *w:*

$$\frac{e(w)}{e'(w)} = w$$

$$\frac{e'(w) \cdot w}{e(w)} = 1$$

This final equation is called the Solow condition and tells us that with unconstrained labor a firm will pay a wage where the elasticity of the wage with respect to effort is equal to 1. The Solow condition tells us that the efficiency wage is not related to the reservation wage. If the relationship between wage and effort were known, it could be plugged into this equation to determine the profit optimizing wage.

2.1.4 Criticisms

Some of the efficiency wage models suffer from a possible theoretical difficulty. More complicated labor contracts can in fact restore pareto optimum equilibrium and return the labor market back to neoclassical standard results without paying above market wages. For example, if all firms required an employment fee, it would provide a substitute nonshirking incentive to the threat of unemployment, and also lower labor costs to equilibrium levels. A number of these types of more complicated employment contracts have been proposed including bonding, fines and seniority wages. However, it is possible that more complicated contracts are not practical or efficient, given the difficulties in communication, interpretation and the resulting misunderstandings (Akerlof & Yellen, 1986). Also, these kinds of challenges to the efficiency wage model result in a moral hazard situation for the firm. The firm would have incentive to declare workers as shirkers, and collect the bonds, fees or fire senior higher paid workers. This, of course, may result in workers being unwilling to accept these more complicated contracts.

2.1.5 Empirical Testing

Empirical testing of nutrition and output has been conducted in developing countries where below sustenance nutritional levels have been shown to impact output. As previously mentioned Bliss and Stern (1978) and Leibenstein (1957) present empirical evidence that increases in the nutrition of workers can sufficiently increase the productivity of those workers to outweigh the cost to the employer of the higher payment to workers.

Another key work is that of Raff and Summers (1987) relative to Henry Ford's wage. Raff and Summers conduct a case study on Henry Ford’s introduction of the "five dollar day" in 1914. Their conclusion is that the Ford experience supports efficiency wage interpretations. “Ford’s decision to increase wages so dramatically (doubling for most workers) is most plausibly portrayed as the consequence of efficiency wage considerations, with the structure being consistent, evidence of substantial queues for Ford jobs, and significant increases in productivity and profits at Ford. Concerns such as high turnover and poor worker morale appear to have played a significant role in the five-dollar decision. Ford's new wage put him in the position of rationing jobs, and increased wages did yield substantial productivity benefits and profits" (Raff & Summers, 1987, p. S83). However, this is not a true data test as the study was only an interpretive study with Raff and Summers reading the history and providing their view of its meaning.

In developed countries testing the connection between wage and productivity has proven more difficult. Effort is not directly observable, especially in team efforts and coordinated production processes. How to measure effort has been the missing link in previous studies. Unable to directly observe labor effort in common modern team oriented production processes, previous studies have relied on indirect measures like the level of supervision (Abowd, Kramarz, & Margolis, 1999) or on management surveys (Campbell & Kamlani, 1997). This is clearly a weak approach because the level of supervision could be influenced by a large number of causal factors other than labor effort. Included in this group of factors could be cost cutting, supervisory capability and effort, and nonremuneration related loyalty programs. Comparable plant level noncurrency data for measuring labor productivity is hard to come by. Most firms track and maintain historical information only for required accounting systems while productivity data requires collection from multiple tracking systems (hours worked, inputs, outputs etc). Sometimes these data are created in short-term operational systems, but rarely are they summarized and saved in historical systems comparable across plants. That is why the data for this particular study are unique and valuable.

2.2 Institutional Wage Theory Literature Review

Lloyd Ulman at the University of California, Berkeley proposed that the development of institutional thought could be described by James Tobin's famous statement about market forces i.e., "market forces do not count; market forces do too count; market forces count for everything" (Kerr, 1977, p. vii). The original modern institutionalist, led by J.R. Commons, focused on historical processes and organizational practices and as a result stressed how market forces were overcome by institutional structure; i.e., market forces do not count. Newer institutionalists allow for market forces and then add institutional rules and boundaries to create a realistic explanation of the observed world behavior, i.e., market forces do too count. The traditional neoclassicalist would contend that market forces count for everything. In discussing the views of the modern institutionalist some of the ideas and explanations that will be covered include:

- The role of industry structure and the impact of single firm skills
- The Balkanization of labor markets
- The two-sector labor market with good jobs and sponge jobs.
- The concept of sufficient job satisfaction versus maximization of opportunities.
- Managers' obligation to employees.

2.2.1 The Role of Industry and Firm Structure

Institutionalist have attempted to find the industry characteristics that lead to a firm paying high wages. Krueger and Summers (1988) show that interindustry wage dispersion is large and consistent across time and countries. Their evidence suggests a pattern that some firms pay high wages across and within all occupational groups and some firms have low wages across and within all groups (Leonard K. L., 1987). In fact, they are led to conclude that "The competitive model cannot without substantial modification provide a plausible explanation of inter-industry wage variations" (p. 18). This in fact is a specific answer expressed to one of the key questions raised in the introduction to this research.

Krueger and Summers (1988) argue that there are two characteristics which determine whether a firm pays high or low wages. They are, first, whether or not a firm can profitably pay high wages and, second, the level of industry union density. The ability of a firm to pay high wages can be assumed to relate to the intensity of competition it faces. Clearly monopolies, oligopolies and monopolistic competitive firms have more ability to pay high wages than do firms in a truly competitive market. Similarly, firms with a low percentage of costs tied up in labor have the ability to pay high wages.

However, this correlation they demonstrate should not be taken beyond what it is -- simply a correlation. If the forces that lead to high pay were applied equally across all firms, only those firms with the ability to afford high pay would respond to these forces leaving the observed result the same. Interestingly, Dickens and Katz find it odd that profits are positively correlated with high wages. Their mind set is back in old thought processes where high wages are a tradeoff to high profits (Leonard K. L., 1987). While empirically valid, Kruger and Summers' correlation is not causation.

The second characteristic Kruger and Summers point out is the importance of industry union density. Dickens and Katz (1987) show that union density is correlated with high wages for both union and nonunion employees. However, this applies only to large firms and not smaller firms, even within the same industry and labor pool (Leonard K. L., 1987). Apparently small firms are either not responsive to the union pressure or unions have no interest in organizing the small firms. However, once again, this is not causation, only correlation. Unions have tended to concentrate their organization in industries that were known to have the ability to pay high wages and in fact already paid high wages prior to union organization (Kwoka, 1983).

Arthur Alexander is a little more specific in his studies about what industry characteristics lead to high wages. He starts with capital intensity. Capital intensity portends a commitment to the long term and perhaps much industry specific human capital. He also includes product market concentration, size of the firm and unionism as referenced above.

Not only do industries have specific characteristics but certain firms do as well. These could include production skills and techniques as well as behavioral and bureaucratic expectations. The reasons that this human capital would be firm specific could include unusual or unique production capabilities and or unusual or unique cultural environments. This would be amplified in a privately run company where owners were personally involved such as in the case study for this research. When developed skills may only be used within an individual firm it creates an important worker-firm attachment. In this case it is not efficient for either the firm or the worker to shift employment. Since skills already acquired have sunk costs, turnover will not be called for even in the case of temporarily reduced demand (Kerr, 1977). This discussion around a worker-firm attachment is an institutional version of efficiency wage. It does not make economic sense for turnover to take place and therefore must be avoided. The difference is that the situation derives from the institutional framework rather than self maximizing behavior.

2.2.2 Balkanization

The term “Balkanization of the labor markets” was introduced by Clark Kerr in his famous essay by the same name. There is no single labor market and the fragmentation of the labor market is evident across industries and geographies. There is a natural structure logically within labor markets because of differences in skills, geography, preferences and information. These natural frictions are supplemented by the introduction of additional institutional rules which totally fracture the market. Kerr (1977) states, “Institutional rules in the labor market, as we have seen, establish more boundaries between labor markets and make them more specific and harder to cross. They define the points of competition, the groups which may compete, and the grounds on which they compete" (p. 37).

Rules can be formal or informal, issued by employers, groups of employees (including unions) and government. Formal rules can be anything from laws against discrimination to union contracts concerning providing employees. Informal rules can include demands from the employer such as no moving costs will be paid, to 5 years of experience will be required. Included in both the formal and nonformal rules will be the far reaching dictate of honoring seniority. Seniority becomes especially important because it ties employees to a certain firm or union. It will provide promotion and security and cannot be transferred with employees when they move locations. These seniority rules, in particular, undermine transfers between jobs. And without free and easy transfers between jobs the idea of the market mechanism breaks down.

The additional impact of these institutional rules and balkanization of the labor market is that there are ins and outs. Those making the rules take care of their own. They have created "sovereignty over a job territory." Fraternity triumphs over liberty as "no trespassing" signs are posted in many job markets (Kerr, 1977, p. 25). This leads directly to a discussion of the two-sector labor market.

2.2.3 The Two-Sector Labor Market

The dual labor market theory divides the labor market into two sectors, the primary labor market and the secondary labor market. The primary labor market has high pay, stable jobs and promotion opportunities. It also provides a high return to education and years of service (Dickens, 1987). The secondary market provides low pay, low job stability and no promotional opportunities. The theory further argues that the primary market is heavily influenced by institutional factors while the secondary market is primarily driven by the free market.

The argument has been made that the primary market arose out of the movement to oligopolies at the end of the 19^{th} and the beginning of the 20^{th} century. As these large oligopolies arose, they turned their attention from short-term competition to long term market dominance. This coupled with a large capital investment sparked the interest in employee stability and development. Personnel departments were created, benefits offered for seniority and job ladders created, and firm and industry specific skills were developed (Reich, 1973).

The secondary market controlled by market forces is often seen as relying on immigrant labor and product demands that are more seasonal, cyclical and do not require the level of capital investment that occurs in the primary market.

2.2.4 Sufficient Job Satisfaction

In weighting the merits of neoclassical versus institutional theories against the structure of the labor market a key question is does the labor market operate with free competitive exchange or are their sets of rules, constraints and norms that dominate. This section will explain the institutional constrains around mobility and flexibility as opposed to a free flowing open market. The vast majority of workers are not actively looking for a job. Some of them may express interest when approached but even then many will express satisfaction with their current job. "They are attached to their jobs or their areas as in a marriage contract" (Kerr, 1977, p. 5). The job may not be the best job in the world, but it is theirs! The personal rewards to work are much more than wage. And sufficient job satisfaction is not just about avoidance of the real unpleasantness of finding a new job match. The personal readjustments are real and difficult in job transfers but a much stronger issue is the alternative reward elements. Workers feel loyalty and attachment to their jobs. They take pride in the progress that has been made in their firm and feel an ownership and sense of community with the other employees in terms of moving forward. The job, with its good and bad, often becomes a part of the employees' identity and sense of self-worth. Some employees have been known to return to the factory cafeteria for lunch each day after their retirement because of the emotional and social attachment to their employment. The primary studies relating to this behavior are related to management studies around employment satisfaction and rewards. The behavioral management studies will be addressed in Chapter 5.

2.2.5 Manager's Obligation to Employees

Managers often view employees as their "team." Lee Iacocca's (1986) assertion that "the chairman [of a publicly held company] is morally accountable to his employees…" (p.284) is a far cry from Friedman's argument that the manager's only role is to provide profits to the shareholders (Friedman, 1970). Much literature has been developed on reciprocal exchange and gift exchange. Managers and employees obtain a psychological utility by working with and supporting each other (Kranton, 1996). The idea of a manager's moral obligation to employees is a social cultural norm that can be developed within societies and institutions.

This idea of "fairness" is supplemented with the idea of social connection. Not only is there a moral obligation but there is also a social obligation to certain employees. This connection has even been shown empirically. "We find that when managers are paid fixed wages, they favor workers to whom they are socially connected irrespective of the worker's ability, but when they are paid performance bonuses, they target their effort toward high ability workers irrespective of whether they are socially connected to them or not" (Bandiera, 2009).

The works cited above would show the following institutional factors as important in wage determination:

- Profitability or intensity of competition/oligopoly
- Union density

- Size of firm
- Capital intensity of firm
- Industry or firm specific knowledge
- Bureaucratic hiring rules relative to experience, personality traits and seniority
- Sufficient job satisfaction and cultural “marriage contracts”
- Closeness of managers to workers – social and joint output responsibility

2.3 Power Relationship Wage Theory Literature Review

A final theory of wage setting is centered on the power relationship between worker and employer. In certain forms this theory can be traced all the way back to the father of economics Adam Smith. In speaking of labor and wages he says, “It is not, however, difficult to foresee which of the two parties must, upon all ordinary occasions, have the advantage in the dispute, and force the other into compliance with their terms” (Smith, 1981 (1776), p. 27). Adam Smith's use of the words “dispute” and “force” are clearly far removed from the neoclassical view of dispassionate optimizing of personal utilities on both parties part. Smith is clearly recognizing a strong social undercurrent present in economic relationships which not only supplements but can overpower the rational optimizing economic man.

Perhaps best known in this arena is the significant work that has developed around Marx’s theory of social struggle and surplus value.

2.3.1 Marxism

Marx notes that the wage actually paid a given worker may be temporarily above or below the normal wage. Supply and demand forces cause oscillations above and below a "certain mean." The mean is the "natural price . . . determined independently of demand and supply." Marx also provides an answer to the question, What determines the height of this mean? What forces establish the "natural" or the equilibrium wage toward which actual market wages are incessantly drawn despite their temporary departure (ScarLett, 2008, para. 5). While Marx's theory of wages started with the view that capitalism would drive wages to a subsistence level, he asserted that the average wage is "that quantum of the means of nourishment which is absolutely requisite to keep the laborer in bare existence as a laborer" *Communist Manifesto* (1848, p.1). Subsequently he then began to add additional items of historical or cultural need to the definition of subsistence.

> In 1865, during his address to the General Council of the First International, Marx presented his fully developed theory of wages. There is still a minimum limit on wages that is basically a physiological minimum but there is no maximum. The determination of where a given wage will lie … is based on the respective powers of the combatants. This seems very similar to the class struggle Marx details in the Communist Manifesto. (Bigelow, 2008, para. 5)

In Marx's world the power struggle between the capitalist and the worker over the produced surplus value is reflected through the wage.

This view of the power relationships would imply that wages going up and down would be a result of shifting power. Power could shift in many ways including the threat of unionization or strike, a significant shock to demand or supply of workers, or legal requirements impacting management approaches to managing workers.

There is a new and different strain of Marxist understanding developing around the labor-capital relationship. This new view argues against two of Marx's key assumptions that end up equating wage labor to slavery and the relationship of worker and employer to unavoidable revolution. This new strain is explained by Laycock (1999) as a view that labor power is not bought and sold as a commodity and that its use in creating surplus value is not a mystery to the laborer. Laycock explains that the transaction of providing wage labor to an employer is one of rental or lease rather than one of buying and selling and that it does not "masquerade as a commodity-exchange (per Marx)" but is fully understood by both employer and employee.

The result of Laycock's argument is that exploitation and expropriation of surplus value is not tied to Marx's labor theory of value, but instead is related to the unequal distribution of capital and land, or the moral injustice of unequal property distribution. This results in a power conflict that is less about the work relationship and wages than it is about the class structure of society itself. According to this view there would be less work conflict over wages as employers and employees share many goals at the place of employment. Instead there would be more social conflict outside of work. The impact on power relationships regarding wages would be somewhat lessened.

Empirical studies have shown that power relationships can make a difference in wages. "Strong unions, centralized wage bargaining, a large public sector and left governments have muted and sometimes overcome inegalitarian tendencies." (Pontusson, Rueda, & Way, 2002, p. 307)

2.3.2 Unionism

While many of the Marxist discussions are quite theoretical, the academic work relating to unions is very much applied. Here bargaining theory, game theory and negotiation theory are all about achieving results. Despite the current decline in union membership, union bargaining is both historically and currently very important to the world of wage setting. While union density has decreased, collective bargaining coverage is still quite high because in most European countries collective agreements prohibit differentiating between union and nonunion employees. According to the OEDC (1997) union density for member countries is 44% but collective bargaining is 68% (Cahuc & Zylberberg, 2004).

Union bargaining theory has developed significantly over the last 2 decades and includes new trends in institutions and the environment which are significant. Centralized wage bargaining which has been found to be the most effective in eliminated wage dispersions is becoming less and less relied upon in the current more complicated and global business environment. Movement toward a more flexible wage settlement is being used by powerful employee groups and unions alike (Pontusson, Rueda, & Way, 2002).

Other reasons for the significant change in the approach to union negotiations are the significant decline of union coverage in the private sector, and also the considerable changes in management approaches. Clawson and Clawson (1999) describe the new environment for labor union negotiations and some of its impacts. Perhaps the biggest management change is the move to participatory management. This would include quality circles, team processes and organizations. These management approaches solicit worker input and joint ownership of goals and results, which clearly work against animus between employee and employer thereby creating a different negotiating environment for unions. The widespread use of these approaches has encroached upon anticompany union rules prompting some change to existing regulations. The other main change that Clawson and Clawson identify is the alliances that unions are forming with other grass roots organizations, from political action committees to community organizing groups.

The main result of the new environment is an attempt by unions to move from a servicing model back to a militancy model. As a servicing model, distinctions between labor unions and company unions can be blurred, but as a militancy model labor unions can stand independent of company management initiatives (Clawson & Clawson, 1999). These large environmental changes imply that the union negotiation process is also in flux and possibly blur the union impact on wages with other changes.

Bargaining theory perhaps goes all the way back to Edgeworth (1881) where parties divide goods in a pareto optimal way, and then continues with Nash (1950) and Stahl (1972) and Rubinstein (1982) where game theory is developed. If the rules of the game (utility preferences of the players and alternative options) can be described, a best case equilibrium can be modeled.

Models around bargaining have been created and incorporated into economic theory. They include the monopoly union model, markup and union power model. These models can result in efficient outcomes under certain assumptions (Cahuc & Zylberberg, 2004). Empirical studies suggest that unions do in fact increase wages (Cahuc & Zylberberg, 2004).

The three groupings of economic wage theories each describe a different structure and function to the labor market, and as a result end up answering the question, "Why do some firms pay more than the market wage rate?" differently. Because the neoclassical theory predicts no differences in wages, it requires the efficiency wage theory or agency theory to explain how differences in wages can be justified. These appendages remain neoclassical because they rely on the rational man maximizing utility. The institutional theories can explain the difference in wages many ways by referencing the structured rules of the market and the cultural and social objectives that participants honor. The power relationship theories explain an above market wage by recognizing some level of negotiating power that specific workers have achieved.

3. TESTING EFFICIENCY WAGE THEORY

3.1 Overview of Efficiency Wage Test Methodology

Chapter 2 identifies several versions of the efficiency wage model. The most widely used and discussed is the shirking model which relates wage to effort (Stiglitz & Shapiro, 1984). This is the model that will be tested econometrically in this chapter. The other models (the turnover model (Salop, 1979) and the quality model (Malcomson, 1981)) related heavily to corporate culture and will be tested in the management survey outlined in Chapter 4.

The element of efficiency wage theory that has always eluded empirical work is the concept of effort. Employee effort can be readily seen in piece rate or task oriented jobs. However, in most of our modern work environments effort is unobservable as large teams work together in interconnected roles to produce common output. This has been the missing link in previous efficiency wage studies. Unable to directly observe labor effort in common modern team oriented production processes, previous studies have relied on indirect measure like the level of supervision (Abowd, Kramarz, & Margolis, 1999) or management surveys (Akerlof , 1982). This is clearly a weak approach because the level of supervision could be influenced by a large number of causal factors other than labor effort.

Included in this group of factors could be cost cutting, supervisory capability and effort and nonremuneration related loyalty programs.

This study will avoid the issue of directly measuring effort by looking instead at output. If Output = $f(e)$ and Effort = $E(w)$ then Output = $f(E(w))$. It is assumed that throughout the relevant range that the first derivative of both $f(e)$ and $E(w)$ is positive, giving output a monotonic and positive relationship with wage. As a result wage premium's impact on output can be measured directly if all other variables can be controlled.

In this case control will be afforded because the production lines used are substantially similar. They are owned and operated by the same company, with the same manufacturing philosophy and policy, with the same technology and making essentially the same products. This will allow us to compare communal labor effort from line to line based on output. The only assumption here is that the level of effort is necessary and sufficient to raise output if the production processes are substantially similar. Because of the direct production information and pay for similar lines across multiple geographies, a production function can be built and a tested for the impact of wage premiums on productivity.

It should be noted that these lines are continuous flow process lines and are not assembly lines. Assembly lines can manage effort from employees by managing the speed of the lines. Continuous flow process lines do not require employees to manually interface with the lines to complete processes. Their speeds are contingent upon the engineering of the line rather than the effort of the associated employees. The associates in a continuous process provide equipment monitoring and adjustment; they coordinate the timing of supplies and provide quality checks. Of course in times of equipment failure they provide whatever manual support they can. With extra effort they can improve uptime, reduce waste, reduce start up times and provide a range of improvement suggestions.

The steps in this test will involve first choosing an appropriate production function and then testing if wage premiums play a role in the chosen production functions. A production function should be chosen first to ensure that the processes of the production line are appropriately represented in real terms (no dollars). This will assure that the production function, which may or may not be a good fit with the wage premiums included, is an appropriate model. The specific statistical approaches and data use will be discussed in detail as necessary.

The other issue of concern goes back to the wage premium of the individual versus the group. At its core, efficiency wage premium is about an economic individual responding to personal incentive. Can the output of a group and the wage premium of the group be measured in the same way? If the wage premiums of each individual within the group go up and down together, then the incented response of the group should be directionally the same as the response of the individual even if not identical in magnitude. As will be explained in the data sections on Mars payroll data, and the BLS base pay data, the data are not available for a true individual comparison, and of course the ability to measure output (a necessary part of this test) is impossible at an individual level given the group dynamics.

An overall sense of the group versus individual can be obtained from a comparison of the payroll premium by category of worker across years and across plants. This comparison is shown in Table 3.1. The categories of High, Medium and Low correspond to the pay zones of employees as explained in the payroll data section. These results show a high level of consistency in movement - all premiums increase between 1993 and 2000. They also show horizontal consistency with 75% of the year to year comparisons having the same rank or position of premium within location. Because the data set is small the standard deviation is large. A statistical comparison would show all the data points within the same 95% confidence interval, however this is not particularly meaningful as the interval would also include negative wage premiums. The consistency of the data within and between the groupings gives support to the idea that group wage premiums can be used along with group output to measure the production input of the wage premiums.

3.2 Plants and Data

3.2.1 Manufacturing Plants

The manufacturing plants used in this study have been selected from four cities, Albany Georgia, Cleveland Tennessee, Chicago Illinois and Waco Texas. Cleveland Tennessee is near Chattanooga and will be referred to as Chattanooga in the rest of this study. These cities represent a diverse set of locations. None are

Table 3.1 Wage Premium by Pay Zone

	WACO		ALBANY		CHICAGO		CHATTANOOGA	
	1993	2000	1993	2000	1993	2000	1993	2000
HIGH	23%	47%	10%	42%	7%	15%	28%	36%
MEDIUM	51%	61%	52%	59%	24%	55%	36%	81%
LOW	26%	37%	49%	87%	13%	69%	20%	23%

especially high income areas (normal for the location of manufacturing plants). But Chicago and Chattanooga enjoy significantly higher income and are larger cities than either Albany or Waco. Chicago is heavily unionized with a significant manufacturing base. The other locations do not have a strong union presence. Each area has a sufficient manufacturing base and civilian labor force to provide a competitive labor environment. While smaller, Albany has a major Coors brewery and Procter and Gamble, and Waco has Raytheon, Cargill and Pilgrim's Pride among other manufacturers. The location demographics are shown in Table 3.2.

The plants are all well established and range in age from over 60 years old to over 30 years old. A number of the plant production workers at each site have been employed for 20 years or more. During the 1990s each plant was operated by a senior management team composed of a plant manager, an engineering director, an operations manager and a finance and human resource manager. The Albany

Table 3.2 Location Demographics

	ALBANY GEORGIA	CHATTANOOGA TENNESSEE	CHICAGO ILLIOIS	WACO TEXAS	YEAR	SOURCE
City Limits Population	72,092	153,487	2,661,688	108,689	2006	Fact Sheet
Metro Area Labor Force	54,000	235,039	4,137,250	101,874	2000	EEO Data Tool
Mfg Firms with >20 Employees	70	370	2,185	153	2007	Economic Census
Median Family Income	38,772	50,282	53,381	39,791	2008	Fact Sheet
Median FI Ratio to US average	61%	80%	84%	63%	2008	Fact Sheet
Labor Force College Graduate	22%	24%	30%	19%	2006	Fact Sheet
	All data from the U.S. Census Bureau Web Site www.census.gov					

plant was built originally to process peanuts for use in other plants, but also now has lines that produce filled pretzels and sugar candy. Chattanooga is a very large plant that makes a variety of M&Ms candies and Twix bars. Chicago makes a variety of filled bars including Snickers, 3Musketeers and Milky Way Bars. Waco produces Snickers bars and sugar candy under the brand names Starburst and Skittles. Each plant also has a chocolate plant that turns chocolate liquor, cocoa butter, sugar and milk into finished chocolate.

The basic production technologies have been in place for many years at each plant. However new technologies are added into the lines to improve quality or efficiency every year. Most of these base technologies can be purchased off the shelf in ready assembled lines. However the off the shelf lines would be much smaller and would not operate to the level of specifications that the Mars lines have been built up to over the years. The technologies can be grouped as bar lines, chocolate plants, sugar lines and shell coated products.

Bar lines produce such products as Snickers, Twix and Milky Way in a variety of sizes and packages. The lines are long continuous processes. Nougat, caramel and other ingredients are continuously cooked and formed into a slab on a moving conveyor belt where the product is cooled, sliced, chopped to size and then enrobed in chocolate, decorated and cooled. Given the need to heat and cool the product, the lines can be physically quite long so that the temperature changes can be achieved without slowing the line down. Wrapping is done in high speed single lanes and then the product is bagged or placed in a carton and then put in a case and on a pallet.

The role of employees in working on these lines is to observe the operation of the equipment, to adjust speeds and settings and to address emergencies. Additional employees provide the continuously needed supplies and maintain and repair the equipment. From time to time mechanical problems arise which require manual intervention until the problem can be fixed.

Chocolate plants are highly automated and require primarily servicing of the equipment and supplies. The sugar lines have very automated processes but require significant manpower in forming and packaging due to the wide variety of packaging and the very high speeds at which the small pieces are processed.

Coated or shelled products include M&Ms and Skittles. These products are originally formed as a sheet of nibs or lentil shaped centers. These nibs are turned in a coating pan batch process while multiple layers of sugar shell are applied. The coating process is very technically sensitive to temperature and humidity and requires close monitoring by employees. Additional capital is required to process multiple colors/flavors until final blending. The high speed packaging machinery also requires a significant number of employees to monitor and maintain during operation.

The process lines all exhibit certain characteristics. They operate with a variable relation between capital and labor. For all the lines labor can change as shifts change, for example, from three staffed shifts to four while capital remains constant. Also problems or improvements can be addressed with only labor or capital rather than always requiring equal amounts of both. The capital and labor are partially substitutable and partially complementary. The line cannot run without employees and employees cannot produce the product without capital. However, additional capital can replace employees, or additional employees could be used for some operations instead of automating.

Because the lines are very large and expensive, additional capacity is regularly achieved by eliminating bottle necks with capital or labor instead of building new lines. New lines are added only irregularly. The data for this study include 23 lines, and during the 10-year period three lines are retired and three lines are started.

Because the lines are well established and operate in a consistent range of capacity, over the period of the study, a single return to scale is appropriate regarding labor and capital, rather than a life cycle concept of multiple returns to scale. Labor and capital are added to the lines in small increments of a few percentage points difference per year rather than fundamental changes in operations. The large changes are achieved by adding or subtracting shifts of operation which is near a constant return to scale relative to labor but requires no additional capital.

The data used in the efficiency wage test come from two sources, first payroll files from the plants and second centralized production reporting, gathered from the plants.

3.2.2 Payroll Data

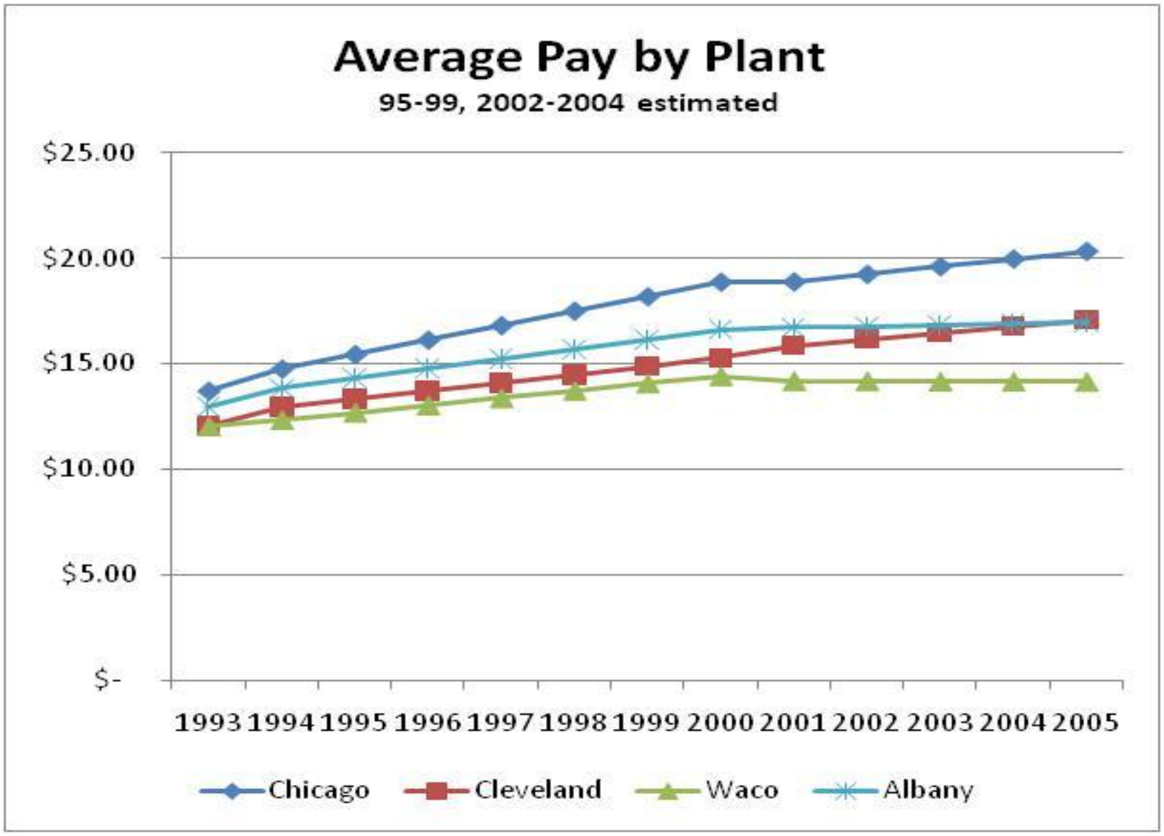
During the study period Mars placed all nonexempt jobs within a pay zone. While five zones exist, the vast majority of employees operate from within three zones. These three zones are subsequently called high, medium and low. Each zone has several steps of pay (approximately four). Employees (called associates by Mars) are paid at one of the steps within the zone for the job they have. Over time an associate can move up the steps within their zone as long as they are performing well. Once an associate reaches the top step in the zone they will receive no more pay increases unless they are promoted to a different job at a higher zone, or the company changes the pay scale within the zone. Since turnover is low, over time most associates working within the same job end up being paid at the top of the zone and are paid the same amount. It is common to see the same pay for multiple associates at each site. Payroll is made weekly and the payroll process is conducted at each individual plant. The data available for this study are associate number and hourly pay for all nonexempt employees from each plant's payroll. This does not include benefits, vacation or bonuses. But this base amount is the correct amount to compare to the Bureau of Labor statistics hourly pay surveys because the government data also do not include these benefits. There is one small wrinkle in the Mars payroll data. The plants all pay their associates a 10% bonus if they are ontime for work. This is paid out with the weekly pay over 95% of the time and is thought of by the employees as part of their pay. While the raw numbers will remain unchanged, in calculating pay premium versus average local pay the on-time pay bonus will be included. A summary of pay data by site is shown in Tables 3.3 and 3.4 and in Figure 3.1. Average pay is the average hourly rate of all nonexempt plant associates. High and low pay represents the extreme hourly wage in the data.

Table 3.3 Mars Payroll Data

	1993		1994		2000		2001		2005	
CHICAGO	**Headcount**	**Wage**	**Headcount**	**Wage**	**Headcount**	**Wage**	**Headcount**	**Wage**	**Headcount**	**Wage**
Average	462	13.69	489	14.74	386	18.87	418	18.88	448	20.33
High Wage		19.17		20.22		23.93		24.29		26.11
Low Wage		9.16		9.86		13.22		12.94		12.44
CLEVELAND										
Average	517	12.04	522	12.95	657	15.27	635	15.87	666	17.09
High Wage		15.74		16.43		19.48		19.78		21.26
Low Wage		6.36		6.36		8		11.47		10.95
WACO										
Average	582	12.02	635	12.33	709	14.43	755	14.2	666	14.16
High Wage		15.99		16.72		20.48		21.83		24.64
Low Wage		7.27		7.27		6.27		6.77		7.27
ALBANY										
Average	291	12.93	296	13.83	306	16.63	319	16.72	281	16.96
High Wage		16.45		17.63		20.87		21.18		22.77
Low Wage		8.99		9.63		9.24		12.77		10.08

Table 3.4 Percent Change in Average Wage

	1994/1993	2000/1993	2001/2000	2001/1993	2005/2001
Chicago	7.7%	4.7%	0.1%	4.1%	1.9%
Cleveland	7.6%	3.5%	3.9%	3.5%	1.9%
Waco	2.6%	2.6%	-1.6%	2.1%	-0.1%
Albany	7.0%	3.7%	0.5%	3.3%	0.4%



Note: estimates between the data points are straight-lined.

Figure 3.1 Average Pay by Plant

3.2.3 Production Data

One of the company's owners was a trained engineer. He also believed very strongly that lasting competitive advantage could only be obtained through manufacturing excellence and technology. As a result he required every plant to submit engineering plant performance along with financial data. The unique data are available for approximately a 10 year period in the company's centralized historical repository. Mars calls this information the A30 report. The report was filled out by the financial employees at each site with input from the site engineers. Things like the headcount per line and capital spending by line would be obtained from the financial records, while things like standard operating capacity would be provided by the engineers. The key pieces of data used in this study end up being:

Output (Q) is measured in metric tonnes. A metric tonne is approximately 2204 lbs. While a tonne of Snickers bars may not have the same dollar value as a tonne of M&Ms it would be a consistent output variable within types of lines and even across lines relative to the inputs. The metric used is yearly total output moved into finished goods (this excludes any waste or rejected product).

Headcount (L) is reported in equivalent full time people and is tracked through the payroll system. The number used is the average of weekly headcount for the year.

Standard operating capacity (K) is also measured in metric tonnes. A consistent set of rules is used by all plant industrial engineers to calculate the standard operating capacity. Standard operating capacity is used as a proxy for capital because of several reasons. The first is that dollar value of capital is recorded in the accounting records at cost and so equipment that is 30 years old would not have a comparable value to recently added equipment. The second is that much of ongoing capital spending is related to issues of safety and quality which do not affect output quantities. Standard operating capacity shows the impact on output quantity of capital used on the line without regard to labor.

The following chart, Figure 3.2, shows the data points relating output tonnes to standard operating capacity for all lines. This chart demonstrates a consistent overall relationship between standard operating capacity and output tonnes.

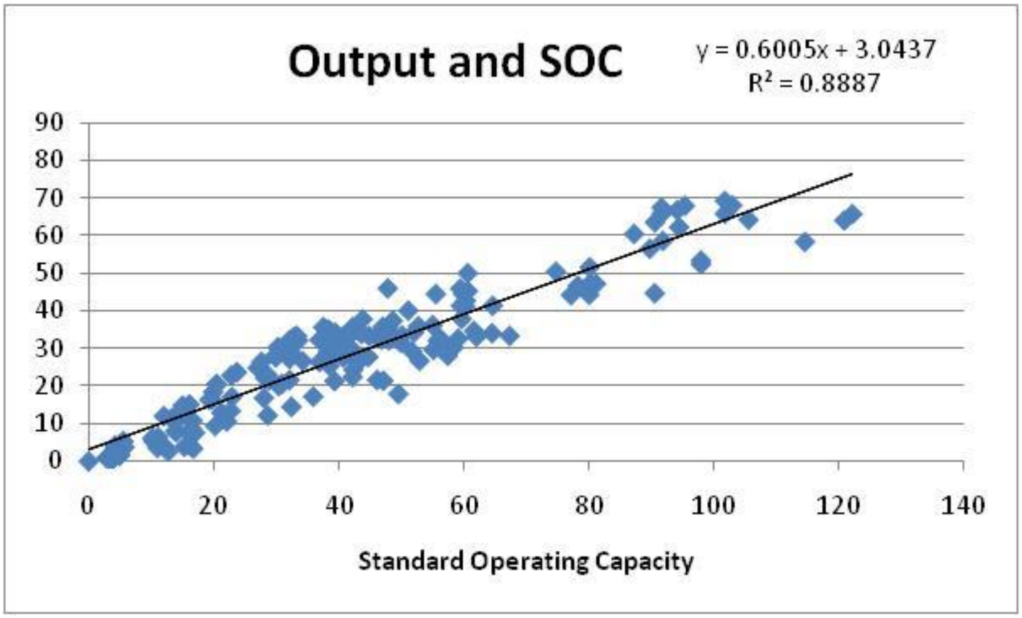


Figure 3.2 Output and SOC

The next chart, Figure 3.3, shows the data points relating output tonnes to headcount for all lines. Because there is a very limited relationship *R* squared of 7% it is apparent that the production lines have different headcount relationships. The next two graphs, Figures 3.4 and 3.5, show the same data limited to Bar Lines and Shell Coating lines which gives a much improved relationship (*R* squared 28% and 83%). These figures demonstrate that the different technology groups have different headcount relationships. In order to capture this difference the fixed effects technique using lines as a grouping proves beneficial in the econometric production modeling.

The following chart, Table 3.5, shows the data that are available for use in the study, by line by year and a range for each of the data points. This demonstrates the breadth of the data as well as the variance sufficent for regression analysis.

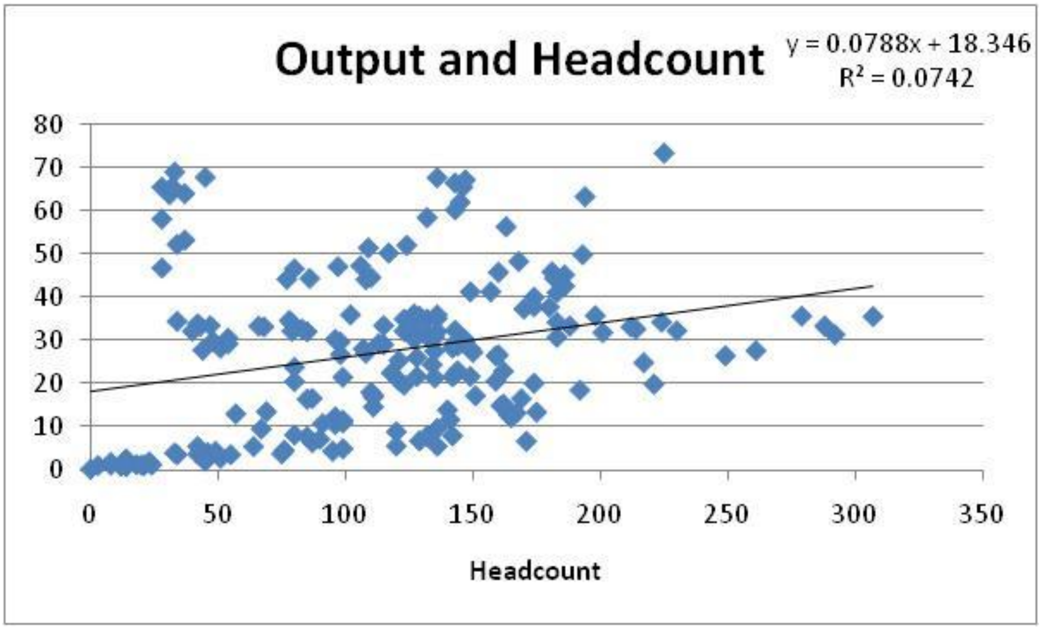


Figure 3.3 All Lines- Output and Headcount

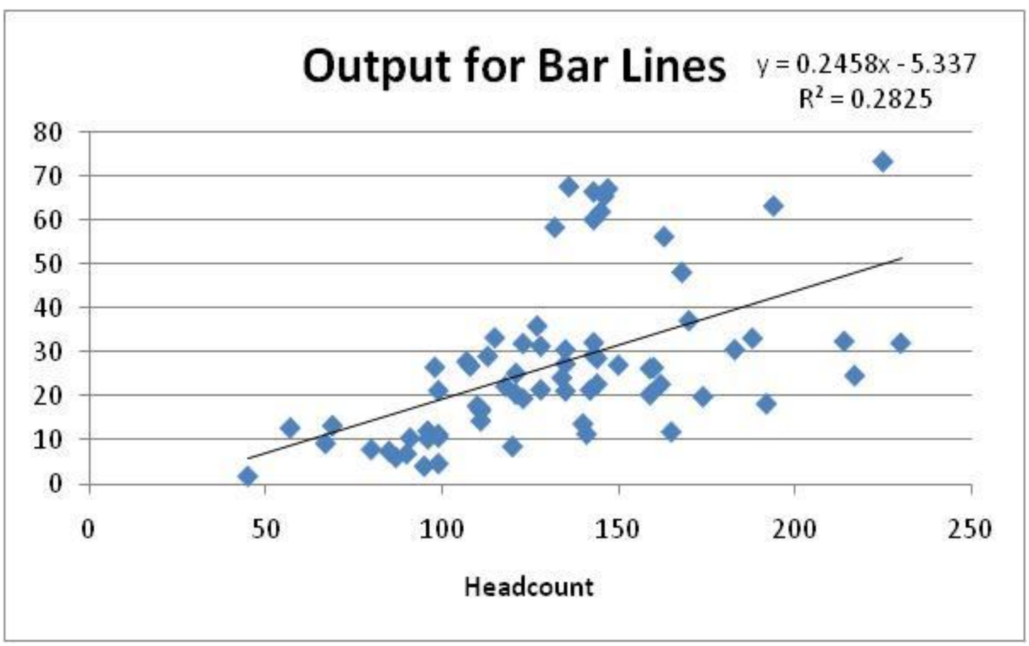


Figure 3.4 Bar Lines - Output and Headcount

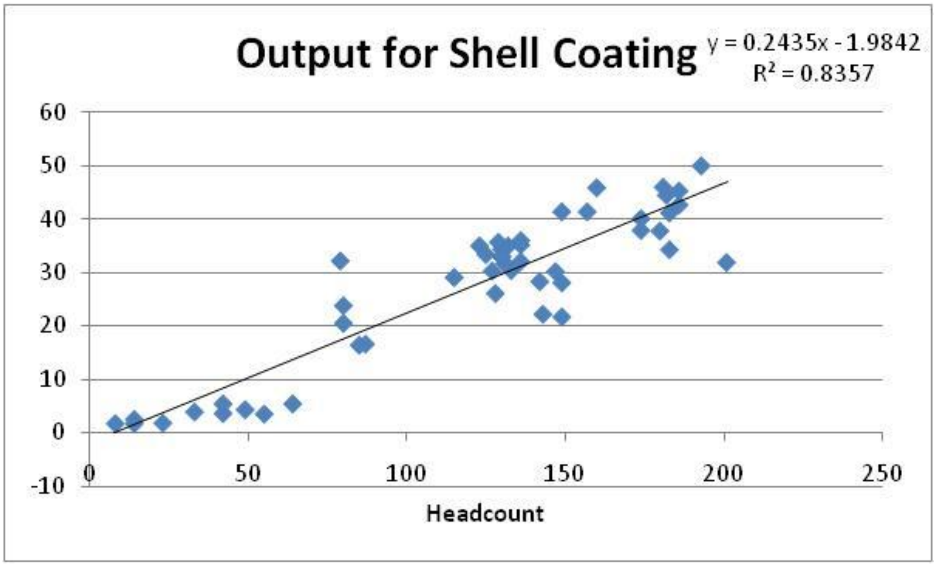


Figure 3.5 Shell Coating - Output and Headcount

Table 3.5 Analysis of Production Data

A30 PRODUCTION DATA							
			RANGE OF DATA (Max-Min)/Min				
Plant	Line	DATA	Volume	Assets	Labor	K/L	Y/L
Albany	Baked Filled Ln 1	93-2002	122%	74%	33%	34%	106%
Albany	Baked Filled Ln 2	93-95	22%	24%	13%	9%	29%
Albany	Peanut Process	83-2002	21%	55%	49%	99%	67%
Chicago	Filled Bar Ln 1 Fs/S	93-2002	82%	115%	132%	39%	54%
Chicago	Filled Bar Ln 2 Sng	93-2002	81%	122%	73%	49%	32%
Chicago	Filled Bar Ln 3 Snck	93-2002	143%	84%	237%	266%	136%
Chicago	Chocolate Plant	93-2002	18%	98%	61%	102%	44%
Cleveland	Flex Line	93-2002	114%	63%	89%	31%	180%
Cleveland	International	93-2002	231%	20%	700%	684%	224%
Cleveland	M&M Peanut	93-2002	18%	29%	18%	30%	35%
Cleveland	M&M Plain	93-2002	77%	60%	48%	37%	40%
Cleveland	Twix I	93-2002	594%	22%	119%	118%	416%
Cleveland	Twix II	95-2002	500%	55%	120	71%	173%
Cleveland	chocolate Plant	93-2002	48%	37%	61%	69%	63%
WACO	Line 1	95-2002	122%	63%	57%	123%	134%
WACO	Line 2 Snickers	93-2002	30%	133%	70%	55%	53%
WACO	Starburst	93-2002	80%	87%	55%	113%	101%
WACO	Skittles	93-2002	64%	32%	35%	60%	81%
WACO	Chocolate plant	93-2002	24%	90%	59%	95%	87%
Source Mars A30 production reports 1993-2002							

3.3 Choosing a Production Function

The purpose in this study of choosing a production function is to allow a drilled down look into the role labor plays in producing output as a basis for testing the efficiency wage theory. Efficiency wage theory suggests that all other things being equal, effort is a function of wage, and that output is a function of effort. The Output shape resulting from the effort is assumed to have a similar shape to a traditional production function, i.e., additional effort results in some increased output $\frac{dO}{dE} > 0$, with diminishing returns.

A production function must be selected that provides a reasonable explanation of labor's role in the output process so that the theories around wage, effort and output can be tested. Given a production function, the role of labor can be defined mathematically with a marginal product of labor, a technical rate of substitution and the elasticity of substitution. The selection of the function will be accomplished using a two-step process.

Step 1 : Pick a functional form that logically matches the design characteristics of the production lines being tested.

Step 2: Run regressions of the various acceptable models to see which ones provide the best empirical fits. The judgment of functional fit is usually accomplished by measuring residual errors as either root mean squared errors or mean absolute percentage errors (Wilson, 2009). In addition the coefficients will be measured for significance and the overall formula for reasonability.

3.3.1 *Step One - Logical Match*

The various functional forms for production functions have different characteristics built into the mathematics. These would include the inputs coming in fixed or variable proportion and being either complements or substitutes. The functional form would also include the returns to scale being limited to a single form or having the ability to change from diminishing returns to increasing returns within the same function. The features of difference would also include how technology and scale are applied to the process. For a more complete discussion of the features of various production functions refer to Appendix D. Please also refer to the description of the Mars production lines and the data in the previous section. The features of the Mars production lines being studied would clearly include:

a. having variable proportions of inputs possible and
b. the inputs can act as either substitutes or complements and
c. a single return to scale (approximately constant) would be used through the entire production function.

Given the above we can eliminate Leontief and Additive[1] production forms from consideration. We are left with Cobb-Douglas, Constant Elasticity and Translog formats, which can fit all of our logical constructs. These formats will be tested.

[1] See section 3.3.2.4 for a revision of this conclusion.

3.3.2 Step Two - Empirical Fit

The data are all in physical measures with no dollar values. Production tonnes are used for volume, standard operating capacity is used as a proxy for capital[2] and equivalent headcount is used to measure labor. The data are edited for obvious errors in the standard operating capacity (see data description section for detail). No production lines have been eliminated for the overall fit even though some of them have high estimated errors.

There are several options which can assist in fitting the functional forms. Simple linear regression can be used, or panel data techniques can be used. Because the data are structured by years for each line and plant, the data fit the classical panel data format. Classical linear regression and nonlinear techniques will give a slope and intercept that fits the data as a whole. However there may be different relationships within an individual plant or line (panel data structure) that are "averaged" with this classical approach. This difference has been previously referenced in the data section of this chapter. The different effects that lines or plants might have on the relationships can be teased out using panel data techniques called fixed or random effects. It can easily be confirmed that the relationships within a plant or line are significantly different from the overall data relationship with the following example. Table 3.6 shows the correlation coefficient between volume and headcount for the overall data and for two specific lines.

---

[2] If dollars were used to measure capital, then there would be issues with age of the assets and accounting book value as well as the fact that some assets are put in place for safety or quality measures which do not impact o
utput tonnes.

Table 3.6 Correlation Between Volume and Headcount

Data Set	OLS coefficient	*t* statistic
Overall	.0788	3.98
Chicago Line 1	.1095	8.15
Waco Chocolate	-.247	2.35

Table 3.6 shows significant, (*t* statistic) but very different, relationships. These differences should be captured in the econometric fits of the production function.

The fixed effect model for the Cobb-Douglas form is as follows:

$\text{Ln (volume)}_{it} = \text{Ln(technology)} + \alpha\text{Ln(Capital)}_{it} + \beta\text{Ln(Labor)}_{it} + C_i + \varepsilon_{it}$

Where i represents the fixed effect group and t represents time. Here C_i represents the impact of the specific group. This essentially allows for a different intercept (technology) for each group. A further test can be conducted to determine if the dummy variables add significance to the resulting equation.

Random effects are based on a different assumption. This technique assumes that the data are a sample from a normally distributed population. As such the error term could be different within each grouping. The most likely error terms by group are calculated.

The random effect model is as follows:

$\text{Ln (output)}_{it} = \text{Ln(technology)} + \alpha\text{Ln(Capital)}_{it} + \beta\text{Ln(Labor)}_{it} + u_i + \varepsilon_{it}$ where u_i is normally distributed. An equivalent interpretation is that the fixed C_i's are distributed along a normal distribution.

In deciding whether random or fixed effects is a better way to capture the group impact from the data, Greene (2010) identifies some key differences as:

- Random Effects

  - Small number of parameters
  - Efficient estimation
  - Restrictive assumption for independence of errors.
- Fixed Effects
  - Robust – generally consistent
  - Large number of parameters (can handle without losing degrees of freedom)

The heart of the problem in deciding between fixed and random effects is whether the explanatory variables are correlated with the error terms – endogeneity. If there is any correlation then fixed effects are preferred because random effects are not consistent.

Fixed effects is preferred for this exercise for several reasons:

1. The data set is structured as a population rather than a random sample
2. The number of groups is small (4 plants and 21 lines)
3. The assumption of normality may be suspect given the limited data points per line

The fixed effects group used will be production line allowing for a different intercept to account for differing technical and structural differences by production line.

Another approach which will be used in the fitting process is to fit all the functions in a natural logarithmic form. The Translog production function is already in a logarithmic form. Cobb-Douglas will need to be linearized by converting to logarithmic form in order to use least squares regression. Constant Elasticity cannot be linearized and will need to be solved using nonlinear estimation. Because the

Cobb-Douglas and Translog forms will be solved using logarithmic formats it is important that all of the equations do so. The estimates, residuals and the R squared results cannot be compared if some equations have the dependent variables as a natural log transformation and others do not. Wooldridge (2009) explains the importance of this by showing that the exponent of the predicted log $\hat{Y}$ will systematically underestimate the expected value of Y.

The statistical description of the data used for these empirical fittings is shown in Table 3.7. Given the statistics for Kurtosis and Skewness we will not reject the hypothesis that the data follow a normal distribution.

3.3.2.1 Cobb-Douglas Functional Fit

The Cobb-Douglas is perhaps the most common production functional form used. It provides for a complementary relationship between capital and labor and

Table 3.7 Descriptive Statistics for 10 Years of Production Data

	VOLUME	*SOC*	*HEADCOUNT*
Mean	27.5	39.4	115.6
Standard Error	1.3	1.9	4.3
Median	29.0	36.9	121.0
Mode	33.3	13.8	136.0
Standard Deviation	17.7	26.9	61.1
Kurtosis	-0.3	-0.2	0.2
Skewness	0.4	0.7	0.3
Range	72.8	100.0	304.0
Minimum	0.7	2.9	3.0
Maximum	73.5	102.9	307.0
Count	199	200	199

will provide an output of zero if either capital or labor is zero. However, the Cobb-Douglas form forces the function to have a constant elasticity of substitution of 1. Because there is no reason to assume that this restriction is appropriate for our dataset, this constraint may limit the results of this model from achieving the best possible fit. The regression model for Cobb-Douglas is fit using logs of all data because of the nonlinear structure of the format.

Ln (output) = Ln(technology) + αLn(Capital) + βLn(Labor) + ε

The resulting Fixed Effect equation converted back into standard form is as follows:

$Output = .226K^{.698}L^{.457}$

- The technology factor is .226 (average of fixed effects)
- The exponents add up close to 1 which implies constant returns to scale. This can be tested as follows: F(1, 154) = 0.58 Prob > F = 0.4492 as a result the hypothesis that the coefficients equal 1 cannot be rejected.
- R squared is 90%
- The statistical significance of the exponents and intercept are high, above 99%.
- The coefficients and t statistics are shown in Table 3.8

Another key test for the fixed effects model is to determine if the model with fixed effects is more significant than without. This significance can be confirmed with the

Table 3.8 Cobb-Douglas Estimates

Coefficient	Estimate	t statistic
Capital exponent	0.698	8.15
Labor exponent	.457	9.04
Intercept – technology	.226	4.18

F test of the hypothesis that all fixed effects are zero: $F(22, 174) = 9.4$ Prob = 0.0000. Clearly the Fixed Effects add explanatory power to the model.

3.3.2.2 Constant Elasticity of Substitution Functional Fit

Volume $= B0(B1K^{B2} + (1 - B1)L^{B2})^{B3/B2}$

The Constant Elasticity of Substitution functional form is also commonly used. It has fewer constraints than the Cobb-Douglas because elasticity of substitution is not restricted to 1. However, it is required to be constant throughout the entire function. This restriction may also prevent us from achieving the best possible fit. The Constant Elasticity of Substitution Function exhibits constant returns to scale if B_3 in the function above is equal to 1. The Constant Elasticity form also contains several well know functional forms within it. If B_3 and B_2 are both equal to 1 then the isoquant is a straight line defining a linear production function. If B_2 approaches zero then the form will take a Cobb-Douglas form (Varian, 1992). If B_2 approaches negative infinity then the form will take a Leontief form of perfect complementary inputs.

Using a nonlinear iterative function which minimizes the sum of squared residuals the following equation was derived for the Constant Elasticity Production Function.

Ln version of CES: $\ln(\text{volume}) = \ln(B0) + \frac{B3}{B2} * \ln(B1 * K^{B2} + (1 - B1) * L^{B2})$

RESULT: $\ln(\text{volume}) = \ln(-1.885) + \frac{1.32}{1.14} * \ln(.91 * K^{1.14} + .09 * \mathrm{L}^{1.17})$

Converted into standard format:

Volume $= .1518 * (.912K^{1.141} + .088L^{1.141})^{1.321/1.141}$

The important elements in this function include the following:

- The scale factor .1518.
- The weight of factor inputs – here capital is given a heavy weight of 91.2 while labor has only a 8.8 weight.
- The coefficient B_2 used to calculate the constant elasticity of substitution factor is 1.141. This would imply an elasticity of substitution of

$$\frac{1}{1 - 1.141} = -7.1$$

- A negative elasticity of substitution is meaningless and results from the fact that this equation assumes concavity in the function and in this case the function is convex (Mos-Colell, Whinston, & Green, 1995). Because this factor is close to 1 (1.141) we have an almost flat plane in three dimensional production space. However, there is some curve, it is just small.
- If B_3 were equal to 1 then the function would have constant returns to scale. Because B_3 is more than 1 (1.32) we have increasing returns to scale.
- Despite the previously mentioned objectionable theoretics, this function has a very good fit, as identified by a 99% adjusted *R* squared which means 99% of the deviation from the average output is explained by the estimated equation.
- The *t* statistics for the derived coefficients also provide a high level of confidences (99%)
- The coefficients and *t* statistics are shown in Table 3.9

- Table 3.9 Constant Elasticity Estimate

Coefficient	Estimate	*t* statistic
Scale Factor	.1518	18.25
Factor Weight	.912	32.24
Rho	1.141	4.95
Adjuster	1.32	4.91

3.3.2.3 Translog Functional Fit

The Translog functional form is a generalization of the Cobb-Douglas form; it does not assume constant elasticity or returns to scale. The Translog functional form is very flexible as it has both linear and quadratic terms along with a cross product. This form permits the elasticity of substitution between inputs to vary.

Also the elasticity of scale can vary with output and factor proportions permitting the long run average cost curve to take the traditional U shape (Weins, 2010).

Because of its flexibility and lack of constraining assumptions the translog production form has become popular in current econometric work.

The translog production function in standard two input format is as follows:

$Ln(Volume) = Constant + B1Ln(Capital) + B_2 Ln(Labor) + B_3 Ln^2(Capital) + B_4 Ln^2(Labor) + B_5 Ln(Capital) \times Ln(Labor)$

The results of the regression are as follows:

$Ln(Volume) = -1.247 + 1.669Ln(Capital) - .537Ln(Labor) + .0227 Ln^2(Capital) + .206 Ln^2(Labor) - .233Ln(Capital) \times Ln(Labor)$

- The overall fit provides an R squared of 92%.

- The F test (5,171) that all coefficients are equal to zero gives a probability of .0000.
- Most, but not all of the t statistics on the coefficients are significant.

The coefficients and t statistics are shown in Table 3.10.

In order to have constant returns to scale the conditions outlined in Table 3.11 must be met (Bairam, 1998):

This fit does not yield constant returns to scale. Also, this fit has an unreasonable area of the curve where if capital is very high and labor is very low the marginal product of labor will be negative. While this does not happen normally in our current data set, it does not seem to be a particularly meaningful portion of the curve.

Table 3.10 Translog Estimate

	Coefficient	t Statistic
Capital	1.669	4.16
Labor	-.5378	2.95
Capital squared	.0227	.38
Headcount squared	.206	4.95
Cross product	-.233	2.83
Constant	-1.247	2.05

Table 3.11 Translog Constant Returns to Scale

Condition	*Results*	*F Test probability*
$B_1+B_2 = 1$	*1.669 -.5378 = 1.13 is close not equal to 1*	*73.3%*
$-B_3=B_1$	*-.0227= is not equal to 1.669*	*0.00%*
$-B_4 = B_2$	*-.206 = is not equal to -.5378*	*2.97%*

3.3.2.4 Additive Production Function

Previously the additive production function had been eliminated for logical reasons (see Choosing a Production Function in this chapter). At this point that decision will be reconsidered. The resulting curve for the Constant Elasticity of Substitution, which has a very good fit (*R* squared 99%) is very flat. While clearly for these processes Capital and Labor are complements, and one could not produce output without both of the factor inputs, in the short-term, it is possible they can act as pure substitutes. For example if a line has a bottleneck or a breakdown, in the short-term the problem can often be solved with either capital or labor fixes. Because of this short-term effect, the Additive Functional form will be included in the study, and to be consistent with the other results the form will be expressed with natural logs.

Base form Volume = B0 + B1*Capital + B2*Labor

Log form ln(volume) = ln(B0 + B1*Capital + B2*Labor)

The resulting fit ln(volume) = ln(-2.896 + .67*Capital + .02*Labor)

or in standard form volume = -2.896 + .67*Capital + .02*Labor

- The adjusted *R* squared is very high: 99%
- The *t* statistics are significant for all coefficients - above 1% level.
- The additive form is very restrictive, being a flat plane it has both constant returns to scale and infinite elasticity of substitution.
- The coefficients and *t* statistics for the Additive form are shown in Table 3.12

Table 3.12 Additive Estimates

	Coefficient	*t* Statistic
Constant	-2.896	6.47
Capital	.669	25.36
Labor	.020	4.3

3.3.2.5 A Comparison of the Four Models

All four models provide good fits and a reasonable estimation of the coefficients as determined by errors and *t* statistics and logic (size and signs of coefficients). The only troubling element is the increasing returns to scale found in the Constant Elasticity model.

As previously identified the key way to judge the goodness of fit is to measure the size of the residual errors resulting from the estimations. The two most common methods are to use the root mean square error and the mean absolute percent error. These comparisons are shown in Table 3.13.
Under both of these measures the Constant Elasticity Function shows a better empirical fit. However, the other three production functional forms still provide very good fits and should not be summarily dismissed.

Table 3.13 A Comparison of the Goodness of Fit

METHOD	Cobb-Douglas	Constant Elasticity	Trans Log	Additive
RMSE	.284	.020	.313	.033
MAPE	9%	7%	10%	9%

However there are several concerns that should be noted, first the Cobb-Douglas, Constant Elasticity and Additive functional forms include some restrictive assumptions which force a certain shape. Also the Constant Elasticity of Substitution has increasing returns to scale which are unreasonable, and the shape is very flat. The Translog function presents a concern by not approaching constant returns to scale which should be expected across a mature stable production process, and under certain conditions results in a negative marginal product of labor. A further comparison of the three models can be found in the statistics listed in Table 3.14.

Using a midpoint of the data range (50 for capital and 150 for labor) the functions would estimate the following output shown in Table 3.15. These are incredibly consistent results and are reflective of the extremely good fits across the various estimated functional forms.

Table 3.14 Comparison Statistics

	Marginal Product of Labor	**Elasticity of Substitution**
Cobb-Douglas	$.103\frac{K^{.698}}{L^{.543}}$	$\frac{d\ln(\frac{L}{K})}{d\ln\lvert TRS\rvert} = 1$
Constant Elasticity	$.025(.912K^{1.141}+.088L^{1.141})^{.16}L^{.14}$	Note: A negative σ is not meaningful and is due to the fact that the function is convex. $\frac{1}{1-1.141} = -7.1$
Translog	$[.12\ln(L)K^{1.67} * 1.25^{(\ln K)^2} - .067K^{1.67} * \ln(L) - .154K^{1.69} * 1.25^{(\ln K)^2}) * L^{-.1537}] * (1.23^{(\ln L)^2} * L^{.233\ln K})$	Too complex to be shown here
Additive	.02	Infinite

Table 3.15 Comparison of Outputs

METHOD	Cobb-Douglas	Constant Elasticity	Trans Log	Additive
Volume Output	34	34	35	34

While one might argue that one of the forms is superior to the other based on either the consistency with engineering design of the lines, or the goodness of fit, it is clear that they all represent very good fits with the data as is shown in Table 3.16. There is no need to eliminate forms at this time. The purpose of the empirical fitting is to ensure that we have reasonable forms on which to test the impact of wage premiums. We can use all these forms to test the efficiency wage hypothesis and if we get consistent results in all circumstances it will serve to strengthen the findings. A graphical representation of each of the fitted production functions is shown in Figures 3.8-3.11. These shapes show a generally flat area for the middle portion of the curve where most of the data exists, but show significant differences around the edges of the curves.

3.3 Calculating the Wage Premium

The wage premium is calculated as a percentage of pay for Mars associates over the average pay for similar jobs in the local market. Mars associate pay is described in a previous section of this chapter and is a per hour wage average for all

Table 3.16 Comparison of *R* squared and MAPE

METHOD	Cobb-Douglas	Constant Elasticity	Trans Log	Additive
R squared	90%	99%	92%	99%
MAPE	9%	7%	10%	9%

nonexempt associates. This will include the appropriate mix of technicians, high level operators and lower level servicers employed. The market pay to compare this with is obtained from the U.S. Government Bureau of Labor Statistics (BLS).

The BLS has been calculating statistics related to pay and employment for over 60 years and is the recognized source of market level data. They provide many statistics but the reports of interest to this research are the hourly pay by job within a market. The hourly pay by certain markets has been captured by the BLS since before 1970. The data needed for the 1990s are nothing new to the BLS as it is a continuation of surveys that have been completed for many years. In 1991 and 1992 the BLS prepared what they call Area Wage Surveys. These were completed every year[3] for 120 markets (geographies) and show, by job classifications the hours worked, number of employees and average and medium pay.

In 1992 the name of this report was changed to the Occupational Wage Survey but it kept the same geographies and job classifications. The data were compiled by the BLS through surveying establishments with over 50 employees and reaching a sample size (in all cases included in this research) of over 50% of the market. The data were then projected by the BLS to represent all establishments in the area. In 1997 the BLS again changed their survey to the National Compensation Survey. Over the next few years they adjusted some of the market areas to better represent changes in population patterns. They also changed the classification of jobs or occupations at this time.

[3] For certain markets limited to every other year.

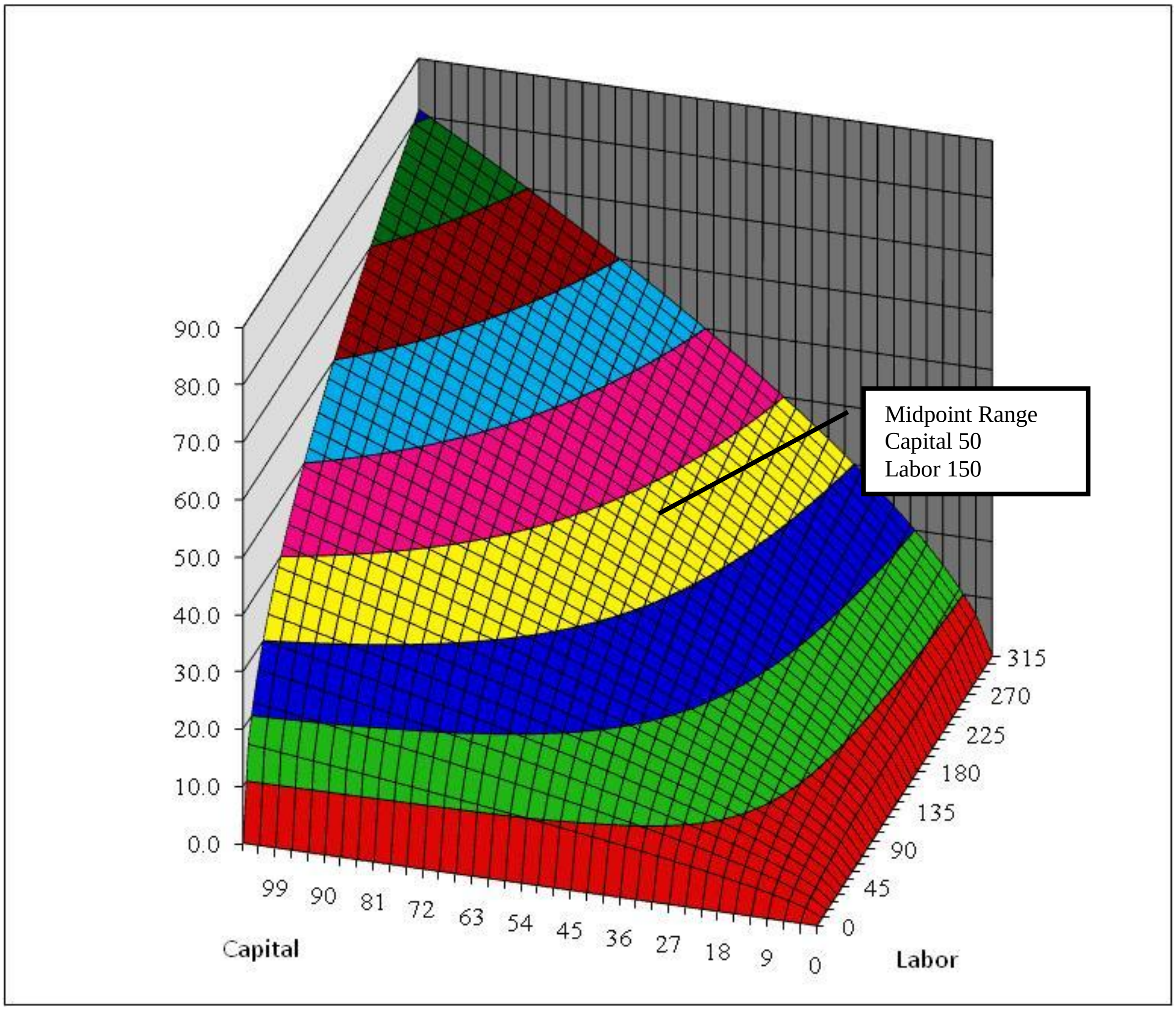


Figure 3.8 Resulting Cobb-Douglass Functional Form

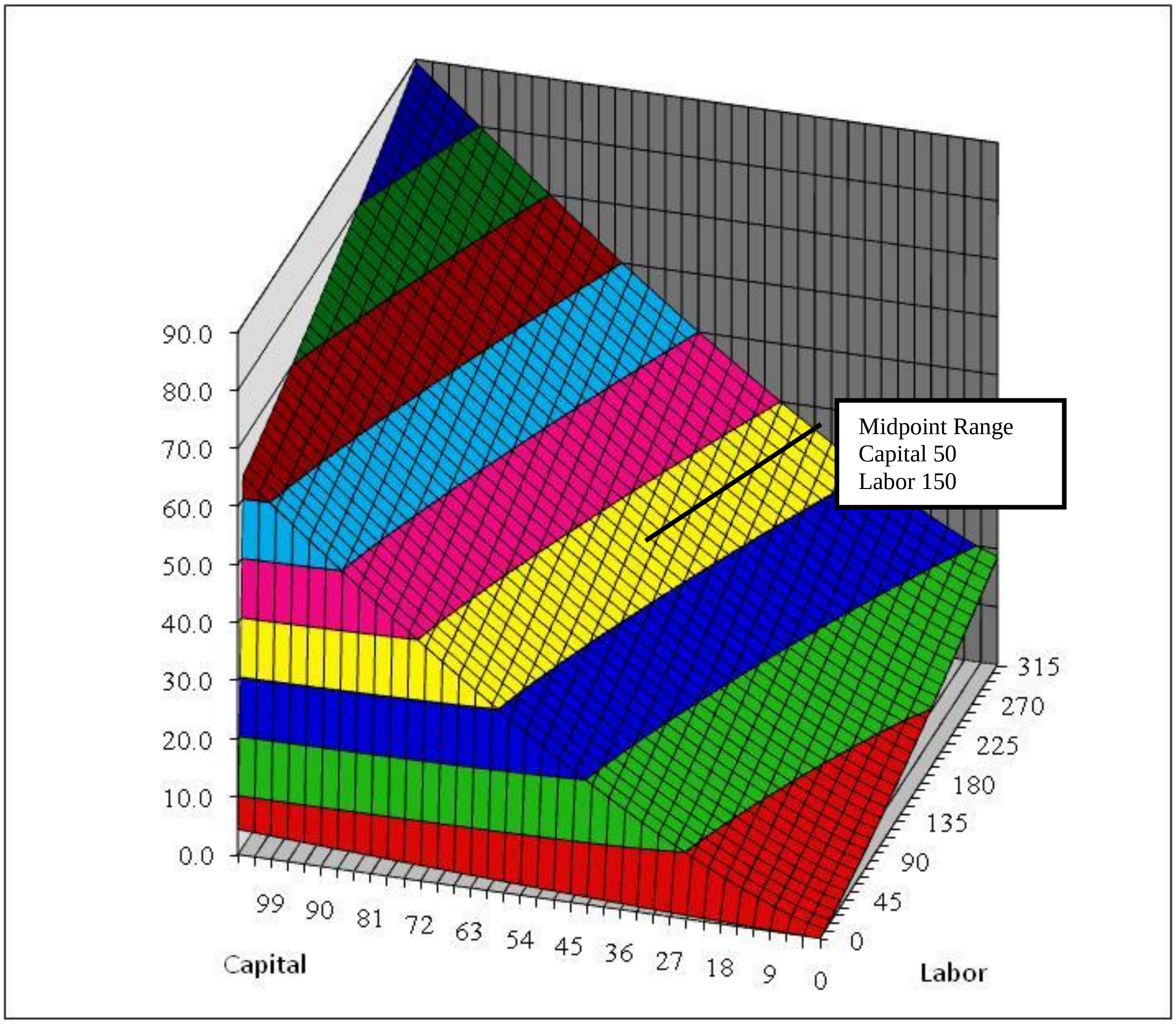


Figure 3.9 Resulting Constant Elasticity of Substitution

Functional Form

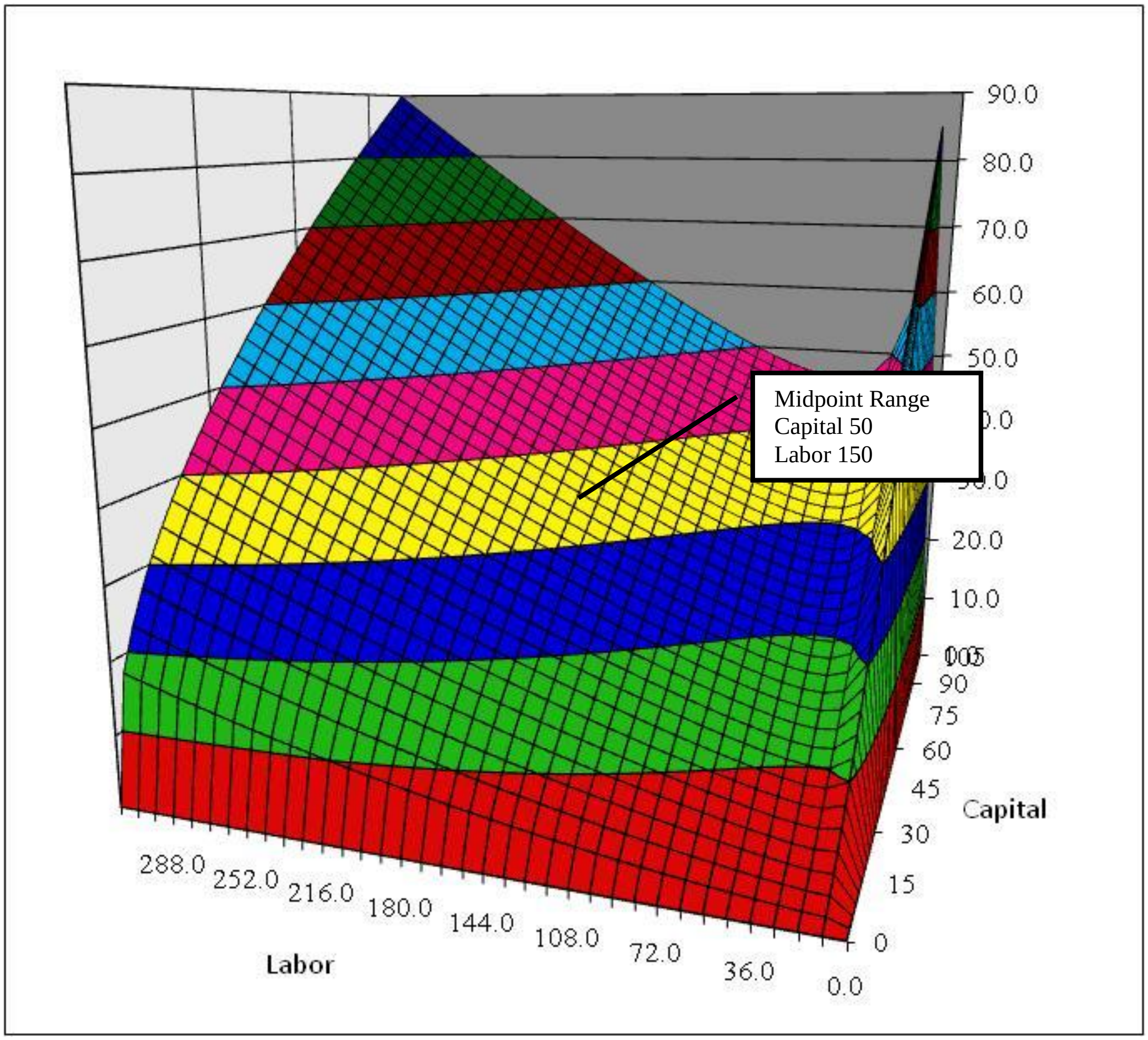


Figure 3.10 Resulting Translog Production Functional Form

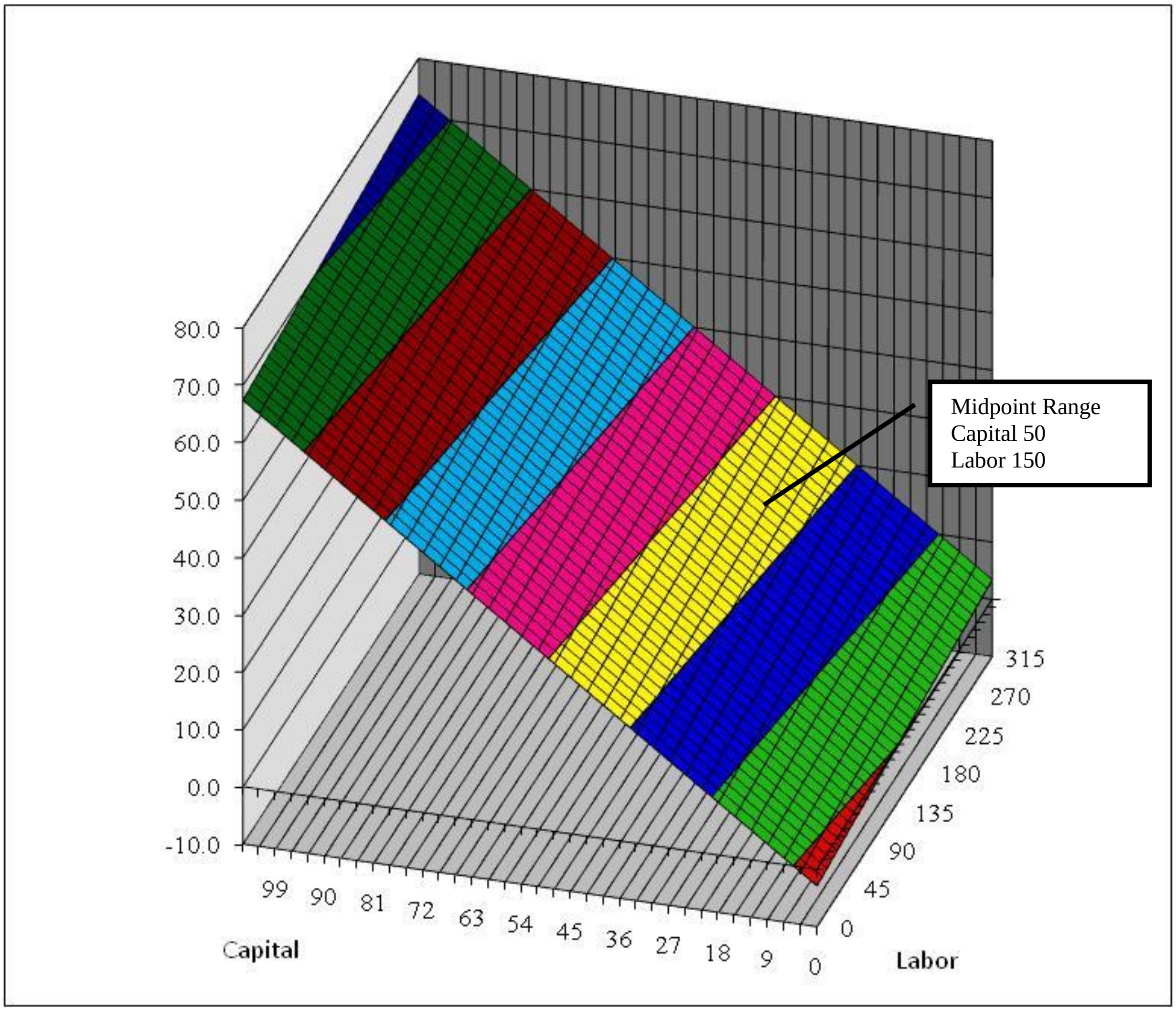


Figure 3.11 Resulting Additive Functional Form

The data collected were from the following sources identified in the reference section.

1. Area Wage surveys- BYU Lee Library Government Documents
2. Occupational Compensation Surveys- BYU Lee Library Government Documents
3. Occupational Compensation Surveys- Utah Marriott Library Government Documents
4. Metro Area Cross Industry- BLS Web Site Archived Documents

The BLS data do present some problems. First geographies can change. For markets used in this research two geographies change. The data for the 1993 and 1994 survey for Waco include nearby Killeen Texas but in 2000 and 2001 Waco is surveyed separately. The other change is within Chicago. The borders of the Chicago metro area are large and hard to define. During some of the years different suburbs are included in the definition of the Chicago metro area. Neither of these market issues is considered significant for the pay data used in this study.

The other data problem is that surveys are sometimes conducted every other year. For certain key years data will be missing for some statistics. This can be solved by simply averaging the data from the year before and the year after. While not precisely accurate it will give a reasonable measure as pay changes moderately over time.

Another data challenge is errors in the survey. At times we see very unreasonable jumps in the wages for a given year and then they decline to previous levels the following year. Jobs are classified by individual survey participants and one year they might include a worker as a fork lift driver and the next year as a warehouse specialist even though the worker's job did not change. This along with the sample selection and participation rate of establishments included in the survey can cause an occasional obvious error. When errors are obvious, a similar job classification that appears more stable during the period in which the error occurred will be used to stabilize the numbers.

A final related problem is the fact that job classifications changed in 1997. The classifications used after 1996 are much more specific and detailed and do not necessarily match up with jobs pre-1997. This is addressed by looking at the market for which the most detail exists (Chicago) and bridging jobs between 1996 and 1997 the year of the change. This bridge, shown in Table 3.17, shows a reasonable transition between job classifications and provides encouragement that the jobs groupings used before 1996 and after 1997 are consistent.

The wage is weighted overall by the number of Mars employees in the high, medium and low job categories. The weighted average pay between these years increased by 2.1%, providing a reasonable bridge between the job classifications.

Table 3.17 Job Classification Bridge for Chicago

	JOB Pre 1996	WAGE 1996	JOB after 1997	WAGE 1997
High	Maintenance Mechanic	20.07	Heavy equipment Mechanic	19.48
Medium	Warehouse Specialist	11.18	Machine Operator	11.58
Low	Shipping and receiving	10.15	Handlers/Labor	10.64
	Weighted AVG	12.38	Weighted AVG	12.64

Specific market occupations need to be selected and weighted together to provide an appropriate match for the Mars average wage. This is done by grouping jobs into high pay, medium pay and low pay groupings. This roughly corresponds to the pay zones that Mars operates within. The highest pay zone is for hourly technical associates, which include electrical technicians, and machinery maintenance mechanics. Also in this category would be team leaders and quality technicians. The middle pay group would be the experienced machine operators and the lower group would be newer associates who have not yet learned key firm specific skills. The low group is used for hand packaging, material movement and general labor. For the early years of the study the BLS job classification had a limited number of job classifications with actual data presented. These included several maintenance jobs, and warehousing and material movement jobs. No production job categories were included in the earlier job classifications. The criteria used to pick BLS occupations to match to the Mars jobs were: 1)the occupation was consistently available across most of the required years, 2) the occupation was consistently available across the geographic markets 3) the data included a large number of survey participants so that Mars data could not drive the numbers, and 4) the occupation was viewed as reasonable market match with the Mars jobs by the researcher. For the later years of the study the jobs were picked with the same four criteria and then matched through the 1996-1997 bridge using Chicago data. The occupational data used to match the Mars zones are listed in Table 3.18.

Table 3.18 BLS Occupations Used

	Pre-1997	Post-1996
HIGH PAY	Maintenance Mechanic	Heavy equipment Mechanic
MEDIUM PAY	Warehouse Specialist	Machine Operator
LOWER PAY	Shipping and receiving	Handlers/Labor

An average wage comparison was obtained by creating a percentage weight for the Mars job categories by location and then using these percentages to weight the BLS wages. These weights are shown in Table 3.19.

With these percentage weights the BLS data can be weighted into an average to compare with the Mars average wages. A wage premium can then be calculated as a percentage increase over the market base. Table 3.20 shows the market wage from the BLS calculations and the average Mars wage. This comparison results in the following wage premiums shown in Table 3.21 and graphically in Figure 3.12.

Table 3.19 Employee Weights by Zone

CHICAGO	1993	2000
Technician	17%	21%
Operator	53%	51%
Servicer	30%	28%

CHATTANOOGA	1993	2000
Technician	20%	20%
Operator	42%	43%
Servicer	38%	37%

WACO	1993	2000
Technician	23%	22%
Operator	49%	45%
Servicer	28%	33%

ALBANY	1993	2000
Technician	16%	19%
Operator	49%	42%
Servicer	35%	39%

Table 3.20 BLS and Mars Wages

	BLS				Mars			
	Albany	Chattanooga	Chicago	Waco	Albany	Chattanooga	Chicago	Waco
1993	**$ 10.25**	**$ 10.04**	**$ 12.96**	**$ 9.82**	**$ 14.22**	**$ 13.24**	**$ 15.06**	**$ 13.22**
1994	**$ 10.10**	**$ 10.23**	**$ 13.60**	**$ 10.17**	**$ 15.21**	**$ 14.25**	**$ 16.21**	**$ 13.56**
2000	**$ 11.41**	**$ 11.21**	**$ 14.38**	**$ 10.67**	**$ 18.29**	**$ 16.80**	**$ 20.76**	**$ 15.87**
2001	**$ 12.00**	**$ 11.56**	**$ 15.11**	**$ 11.39**	**$ 18.39**	**$ 17.46**	**$ 20.77**	**$ 15.62**
2002	**$ 11.78**	**$ 11.65**	**$ 14.63**	**$ 10.97**				

Table 3.21 Wage Premiums

	Wage Premium			
	Albany	Chattanooga	Chicago	Waco
1993	38.8%	31.9%	16.2%	34.7%
1994	50.7%	39.2%	19.3%	33.3%
1995	52.2%	40.9%	23.1%	35.8%
1996	53.8%	42.7%	27.1%	38.3%
1997	55.4%	44.4%	31.2%	40.8%
1998	57.0%	46.2%	35.4%	43.4%
1999	58.6%	48.0%	39.8%	46.0%
2000	60.3%	49.9%	44.3%	48.7%
2001	53.3%	51.0%	37.4%	37.1%
2002	52.9%	49.0%	41.2%	42.4%

These tables graphically straight-line estimates between 1994 and 2000.

The calculated wage premiums show a premium level starting at a range of 16% to 39% and increasing to a range of 41% to 53%. Two considerations, which partially offset each other, should be considered relative to the size of these premiums. The first is the fact that neither the BLS nor Mars payroll data includes benefits. Mars had an extremely rich benefit package during this period with fully

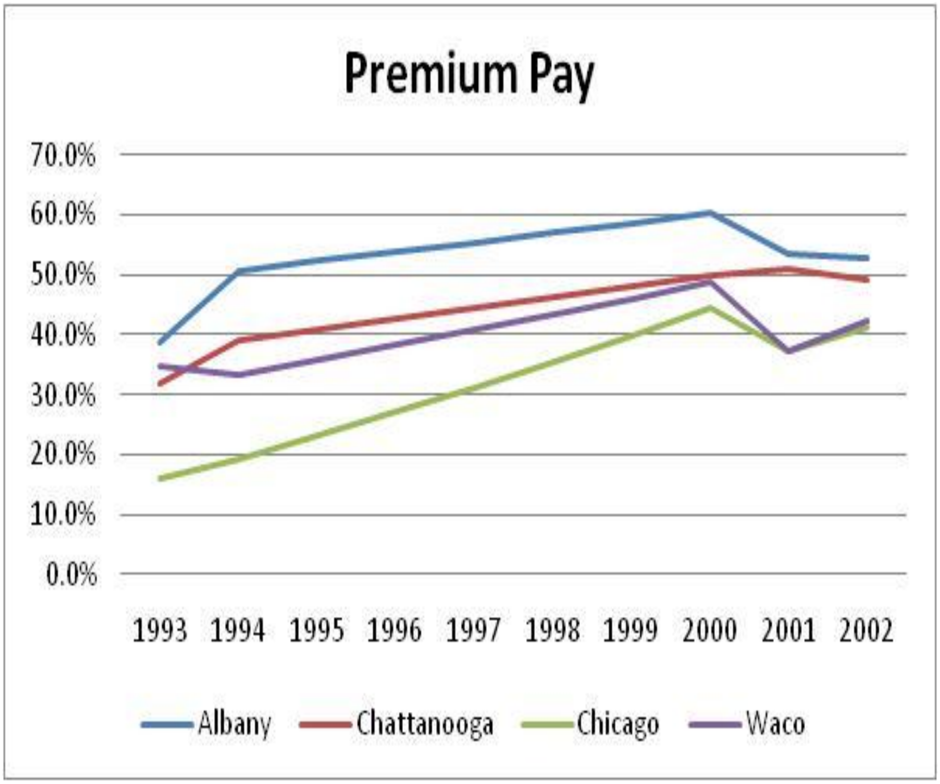


Figure 3.12 Premium Pay

paid insurance and a top defined benefit pension plan. This would tend to increase the possible premiums. The second consideration is the tenure of the Mars employees. Because Mars turnover was very low and pay was indirectly tied to length of service (see 3.2.2 Payroll Data) Mars employees would have an above market average length of service and as a result enjoy a premium wage versus the market based on tenure only. These two partially offsetting considerations are expected to remain constant throughout the length of this study and therefore have minimal impact on the econometric tests.

3.4 Testing the Wage Premiums

All four production models can be run with wage premiums included. The models will then be assessed in two ways. The first is for overall enhancement: Does the model including wage premiums have better accuracy and fit? The second is for individual assessment of the wage premium itself: Does the coefficient of the premium make logical sense and is it statistically significant? These two assessments will allow us to conclude that wage premiums do or do not help us explain production output.

Because wage data were only obtained for 4 years the original models which were run on all 10 years of data do not provide a valid bench mark to measure the impact of the wage premium. It is entirely likely that eliminating the 6 years of data will have a significant impact thereby confusing the effect of including the wage premium. To properly measure the impact of the wage premium an identical base model is required so the only difference will be the inclusion of the wage premium. The four accepted models from the first fitting will need to be rerun with only the 4 years of data which include wage data. This will significantly reduce the number of observations.[4] However there will still be 80 observations for each of the tests, enough to reasonably calculate comparisons.

The same model structure determined most appropriate from the full 10 year fitting will be incorporated into the new base models. All models will be run in logarithmic format and fixed effects will utilized

[4] An additional model maintaining the full 10 years of production data with straight lined estimates for missing wage premiums will be presented as an alternative test in Appendix C.

The descriptive statistics for the data which will be used in this regression test are shown in Table 3.22. These are slightly different from the statistics shown in Table 3.7 because they only include the 4 years 1993, 1994, 2000 and 2001. However the means are similar and while standard deviation increases the measures for Kurtosis and Skewness are still roughly within two standard deviations and as a result are accepted as normal.

3.4.1 Cobb-Douglas Test

The base model covering the 4 years of data has an R squared of 89% and an overall F test of 20.66. The calculated coefficients and significance are shown in Table 3.23.

The model run with three factor inputs including is structured as :

$\text{Ln (Volume)} = \text{Ln(technology)} + \alpha\text{Ln(Capital)} + \beta\text{Ln(Labor)} + \mu\text{Ln(Wage Premium)} + \varepsilon$

or in traditional form Output = Volume = $tK^{\alpha}L^{\beta}P^{\mu}\ \varepsilon$

Table 3.22 Descriptive Statistics For 4 Years with Wage Premiums

	VOLUME	*SOC*	*HEADCOUNT*	*PREMIUM*
Mean	27.1	38.5	117.7	1.39
Standard Error	2.0	3.0	6.7	0.01
Median	28.1	32.1	128.0	1.39
Mode	3.4	14.0	142.0	1.50
Standard Deviation	18.3	27.0	60.0	0.12
Kurtosis	-0.3	-0.1	-0.6	-0.55
Skewness	0.5	0.8	0.0	-0.39
Range	72.8	99.4	241.0	0.44
Minimum	0.7	2.9	8.0	1.16
Maximum	73.5	102.3	249.0	1.60
Count	80	80	80	80

Table 3.23 Cobb-Douglas 4-Year Base

	Coefficient	*t* statistic
Capital	.78	4.05
Labor	.52	5.26

The Cobb-Douglas model has the following results:

The model including wage premium has an *R* squared of 91% and an overall *F* test of 14.24. The calculated coefficients and significance are shown in Table 3.24:

From an overall perspective the model is not improved. The reduction in the overall *F* test shows that there is a slightly higher chance that the model is not significant. However from the individual assessment of the premium we learn that most. The negative coefficient is counter intuitive. It implies that as wage premium increases then output declines. The coefficient is also not significantly different from zero. From the Cobb-Douglas comparison we cannot conclude that wage premiums significantly influence output levels as the efficiency wage theory proposes.

Table 3.24 Cobb-Douglas 4-Year Wage Test

	Coefficient	*t* statistic
Capital	.916	4.02
Labor	.491	4.69
Premium	-.146	1.11

3.4.2 Additive Model Test

The additive model assumes that factor inputs are perfect substitutes. In the efficiency wage model which we are testing wage premiums are not a substitute for labor. Instead they enhance the labor and encourage additional effort. Rather than adding on wage premiums as a separate independent variable, labor will be multiplied by the wage premium percent. This will show a labor amplified by wage premiums as the substitute for capital. This technique for showing the efficiency of labor is an accepted approach (Mankiw, 2009). The additive model augmented to include wage premiums is as follows:

$Ln(Volume) = Ln(Constant + \alpha Capital + \beta(Labor*Wage\ Premium))$[5]

The revised base for the additive model run on the 4 years of data for which we have wage premiums results in:

An adjusted *R* squared of 99.02% and a residual deviation of 31.94. The resulting coefficients are shown in Table 3.25:

After including the premium wages the model results in: An adjusted *R* squared of 98.99% and a residual deviation of 34.84. The resulting coefficients are shown in Table 3.26:

Table 3.25 Additive 4-Year Base

	Coefficient	*t* Statistic
Constant	3.185	3.62
Capital	.661	12.96
Labor	.0248	2.8

[5] Some readers have suggested that wage premium be added as an input to production, substitutable with labor and capital. This format has been run as an additional test and yields a negative (counter intuitive) coefficient for wage premium.

Table 3.26 Additive 4-Year Wage Test

	Coefficient	*t* Statistic
Constant	3.175	3.36
Capital	.678	12.83
Labor	.013	2.21

From an overall perspective the model is not improved, with slight negative adjustments to the residual deviation and the adjusted R-squared. And while there is no specific coefficient for premium wage the coefficient for headcount (which now includes premium wage impact) is smaller and less significant.

Using the Additive model comparison we cannot conclude that wage premiums significantly influence output levels as the efficiency wage theory proposes.

3.4.3 Translog Test

The translog model is a more complicated model with squared terms and cross products. To include wage premiums will require a three-factor model which is expressed as follows:

$Ln(Volume) = Constant + B_1 Ln(Capital) + B_2 Ln(Labor) + B_3\ Ln(Wage\ Premium) + B_4 Ln^2 (Capital) + B_5 Ln^{2(}Labor) + B_6 Ln^{2(}Wage\ Premium) + B_7 Ln(Capita) \times Ln(Labor) + B_8 Ln(Capita) \times Ln(Wage\ Premium) + B_9 Ln(Labor) \times Ln(Wage\ Premium)$

The base model, run as before but with only the 4 years of data results in the following:

An overall adjusted *R* squared of 89.69% and an overall *F* Test of 10.91. The resulting coefficients are shown in Table 3.27.

After including the premium wages the model results in:

Table 3.27 Translog 4-Year Base

	Coefficient	*t* Statistic
Log Labor	-.759	-1.58
Log Capital	.239	.22
Log Labor squared	.220	2.05
Log Capital squared	.204	1.31
Cross product	-.168	.89
Constant	1.05	.57

An overall adjusted R squared of 86.91% and an overall F Test of 3.27. The resulting coefficients are as shown in Table 3.28.

From an overall perspective the model is not improved, with slight negative adjustments to the R squared and the overall F Test. And while there is no single coefficient for premium wage, the coefficients are all now statistically insignificant. An F test on the four coefficients which contain wage premium gives F (4,48) = .64 with a probability of .637. As a result we conclude that there is no statistical significance to including the wage premium into the equation.

Table 3.28 Translog 4-Year Wage Test

	Coefficient	*t* Statistic
Log Labor	-.604	-1.13
Log Wage premium	1.223	1.03
Log Capital	-.166	-.06
Log Labor squared	.194	1.74
Log Wage premium squared	.409	1.47
Log Capital squared	.237	.73
Capital X Labor	-.166	-.84
Capital X Wage Premium	-.0028	-.01
Labor X Wage Premium	-.04	-.21
Constant	2.396	.47

Using the Translog model comparison we cannot conclude that wage premiums significantly influence output levels as the efficiency wage theory proposes.

3.4.4 Constant Elasticity of Substitution Test

The Constant Elasticity model also requires a slightly different form with three factor inputs. The model including wage premium is expressed as follows:

$$\ln(\text{volume}) = \ln(B0) + \frac{B3}{B2} * \ln\left(B1 * K^{B2} + B4 * WP^{B2} + (1 - B1 - B4) * L^{B2}\right)$$

The base model, formatted as previously derived, but with only the 4 years of data results in the following:

An adjusted R squared of 99.40% and a residual deviation of -7.6229. The calculated coefficients and statistical significance are shown in Table 3.29.

After including the premium wages the model results in:

An adjusted R squared of 99.39% and a residual deviation of -7.62844. The calculated coefficients and statistical significance are shown in Table 3.30.

The models are almost identical. The very minor changes in R squared and residual deviation imply a model moving in the wrong direction. The coefficients do not show much change but the significance of the constant and weight for capital take a steep drop. The significance of the scale and Rho show only the smallest

Table 3.29 CES 4-Year Base

	Coefficient	t Statistic
Constant	-1.98	10.74
Scale	1.34	2.62
Weight to capital	88%	16.33
Rho	.925	2.64

Table 3.30 CES 4-Year Wage Test

	Coefficient	*t* Statistic
Constant	-1.8	.765
Scale	1.34	2.59
Weight to capital	76%	.53
Weight to headcount	10%	2.63
Rho	.928	2.63

incremental drop, but again imply a model moving in the wrong direction.

Using the CES model comparison we cannot conclude that wage premiums significantly influence output levels as the efficiency wage theory proposes.

3.4.5 Test Conclusion

It is inopportune that payroll data were limited resulting in the number of observations being necessarily dropped when conducting this final test of payroll impact. However, given the consistent results across all four tests we are forced to rely as much on the preponderance of evidence as on the depth of a more satisfying individual test. The conclusion of the tests is that this specific data sample does not provide any support for the idea that premium wages increase effort which increases output. Table 3.31 summarizes the statistics for the overall fit.

Given the reduced number of payroll observations versus production information an alternative test has been prepared. The entire test above has been repeated using the full 10 years of production data and using wage premiums with the missing data filled in as a straight line between the 1993/1994 and 2000/2001 data points. These estimates are shown in Table 3.32. This test is presented in

Table 3.31 Summary of Overall Fit with Wage Premiums

	Base	W/Premium
Cobb-Douglas		
Adjusted *R* Squared	0.892	0.906
F Test	20.66	14.24
Additive		
Adjusted *R* Squared	0.9902	0.9899
Residual Dev.	31.94	34.84
Translog		
Adjusted *R* Squared	0.8969	0.8691
F Test	10.91	3.27
CES		
Adjusted *R* Squared	0.994	0.9939
Residual Dev	-7.6229	-7.62844

Table 3.32 BLS and Mars Data with Extrapolated Trends

	BLS				Mars			
	Albany	Chattanooga	Chicago	Waco	Albany	Chattanooga	Chicago	Waco
1993	**$ 10.25**	**$ 10.04**	**$ 12.96**	**$ 9.82**	**$ 14.22**	**$ 13.24**	**$ 15.06**	**$ 13.22**
1994	**$ 10.10**	**$ 10.23**	**$ 13.60**	**$ 10.17**	**$ 15.21**	**$ 14.25**	**$ 16.21**	**$ 13.56**
1995	$ 10.30	$ 10.39	$ 13.72	$ 10.25	$ 15.69	$ 14.64	$ 16.90	$ 13.92
1996	$ 10.52	$ 10.55	$ 13.85	$ 10.34	$ 16.18	$ 15.05	$ 17.61	$ 14.29
1997	$ 10.73	$ 10.71	$ 13.99	$ 10.42	$ 16.68	$ 15.47	$ 18.35	$ 14.67
1998	$ 10.96	$ 10.87	$ 14.12	$ 10.50	$ 17.20	$ 15.90	$ 19.12	$ 15.06
1999	$ 11.18	$ 11.04	$ 14.25	$ 10.59	$ 17.74	$ 16.34	$ 19.92	$ 15.46
2000	**$ 11.41**	**$ 11.21**	**$ 14.38**	**$ 10.67**	**$ 18.29**	**$ 16.80**	**$ 20.76**	**$ 15.87**
2001	**$ 12.00**	**$ 11.56**	**$ 15.11**	**$ 11.39**	**$ 18.39**	**$ 17.46**	**$ 20.77**	**$ 15.62**
2002	**$ 11.78**	**$ 11.65**	**$ 14.63**	**$ 10.97**	$ 18.02	$ 17.36	$ 20.66	$ 15.62

Appendix C and importantly confirms the results of the original test presented here. In Table 3.32 years 1993, 1994 2000, 2001 and 2002 are actual data points and other years are straight line interpolations between the actual data points. In this alternative test the original production models can serve as the comparison base.

3.4.6 Possible Reasons for These Results

Given the popular support for the efficiency wage argument and the bulk of articles and test supporting the hypothesis it is a small surprise that we find absolutely no evidence of wage premiums' impact on output. While this research cannot determine the exact reasons why, ideas about the reasons for a lack of significance should be proposed.

One must first consider that, at least in this case, the efficiency wage hypothesis is simply not valid. This is a specific case study for one company and four manufacturing locations. The efficiency wage hypothesis could be reality in many situations but not be a universal maxim, thus allowing for differences in specific situations such as the one in this research. The results of this study apply specifically to the particular data and do not extend to other firms . A corollary of this point is that this case study may be an exceptional situation. And indeed this firm has many institutionally established cultures that could overpower other influences. The specific cultural institutions of this firm are addressed in Chapter 4.

Second, limited data or errors in the data may prevent a true result. Given that the data were sourced directly from payroll and operational reporting systems we believe that the data are as robust as business performance data can be and are much more reliable than the overall averages and macrodata used in the other referenced studies of efficiency wage (see Chapter 2). The limited data extends across four plants each with multiple production lines over 10 years. The specific limits to the data are fully incorporated in the degrees of freedom used in the statistical tests of significance. The type I error that a population characteristic which actually exists will not be found is small (for every test less than 5%).

Even if the efficiency wage hypothesis is valid, over time, in a team production environment the impact may diminish. This may explain why no wage premium impact on output was detected in this study. Efficiency wage may have diminishing effects over time and eventually be replaced with a sense of entitlement. When an employee first starts she accepts the job understanding a wage premium in comparison to her alternative options. The wage premium can attract, motivate and retain per the efficiency wage hypothesis. In a team environment production output per associate is not visible. However, each manager and employee will form a subjective opinion of each team member's contribution. After many years of working side by side with other employees who make the same wage, she will notice that some put forth less effort and are rewarded the same. As a result she will feel entitled to the wage given that she feels she puts forth an average effort. At the locations in the case study there are many long time employees and this would be an interesting employee attitude to test for and understand. This of course could be compensated for if reward, including wage, were differentiated and awarded by effort. In our case study wages of all team members are the same and only the rare promotion opportunity would provide for individual recognition of effort.

4. TESTING INSTITUTIONALISM AND POWER RELATIONSHIPS

4.1 Mars Culture

Mars, Incorporated is known for its unique, strong and pervasive culture. From the early days during the great depression until now many of the values and principles of the company have remained unchanged and uniquely Mars. Most family businesses do not last beyond the second generation, as divided ownership and interest lead to public sale. Mars, Incorporated is now on its fourth generation ownership. This is a testimony to the strong and pervasive culture developed within Mars. This also accounts for the strong institutions that have developed within the culture. These rules of the game, which provide constraints and structure to the employment relationship, all favor premium pay for employees.

The first element of this unique culture comes from being run by family owners. "As a family business we base our activities on family values." (Mars, Incorporated, 2005, p. 19). The family owners worked tirelessly side by side with their employees. The owners traveled extensively to all sites around the world, showing up at 6:00am ready for work. The family has always been very concerned about privacy, shunning personal publicity and did not even allow portraits of the family on display. Because of the family ownership sometimes the profit maximizing rule would not always hold. As an example, one of the family members had responsibility for a factory that burned down when he was young. As a result, he insisted on over-the-top fire protection at all sites. One engineering contractor was asked to sign a confidentiality agreement and said, " I'm happy to sign it but why do you care - no one else would build like this!"

A second element of the unique culture was an egalitarian and paternalistic approach. From the beginning there were no private offices, no private parking spaces, only a few broad jobs. Employees were called "associates" and everyone from the president on down was required to clock into a time clock each morning. Because the owners worked side by side with associates throughout the world their personal exacting standards became a third element of the culture. In terms of stated company values this was referred to as "Quality - the consumer is our boss, quality is our work and value for money is our goal" (Mars, Incorporated, 1983, p. 1). However, the exacting standards were more than a product quality expectation. They included personal commitment . One company lawyer ended up being called in to work on the day of her wedding and she came.

Finally one of the owners (an engineer) had a love of engineering technology. He believed that the only sustainable competitive advantage was a technical one. He insisted on highly mechanized plants and the latest and best technology. This cultural tenet became important in labor policy as higher skilled workers who were willing to learn and progress with technology were required.

Several nonformal institutional practices result from these cultural elements.

The first is increased termination costs. Because of the intense private nature of the owners a threat of publicity was associated with termination. This threat increases the implicit cost of firing a worker or even the voluntary departure of an unhappy associate. Any adverse legal action was avoided at all possible costs.

Second, this firm had a need for employment longevity. Because the owners worked side by side with associates they required a personal trust to be built up over time. They would prefer to work with someone they knew and trusted rather than the latest business savant from outside. As such they needed to encourage employment stability.

Third is a difficult work environment. Because the owners were known to be demanding and because there were no private offices, associates were expected to endure difficult public treatment. If a company wants to be able to berate associates publicly, and change personal decisions and directives at a whim, a company must compensate the employees to offset these negatives associated with the job.

Fourth is the threat of unions. Because the company was a private family owned company the threat of unions was not a simple business issue. The threat of unions was taken as a threat to the family ownership and control of the company.

These rules of the game, which provide constraints and structure to the employee relationship, all favor payment of premium pay to employees in order to attract and keep the right kinds of employees, in difficult circumstances for a long tenure.

4.2 Survey

4.2.1 Why Use a Survey

While performance data were obtained for the efficiency wage test they do not exist to address the other wage theories. This is because the culture, institutions and management policy and practice were the same at all locations and all lines. As a result a management survey will be used to test support of each theory in practice. A survey of those who set and managed wage policy is appropriate given that institutional structures, power relationships and agency theory go directly to the forces that motivated pay setting practices. Many of these questions imply motivational, cultural issues and even fear as a compelling factor. A survey asking directly about these issues can identify their existence and impact. The wage theories that will be addressed by this management survey include agency theory, strength of institutional factors and power relationships. In addition, for the purpose of consistency and support, questions will also address the efficiency wage theory which has been empirically tested in Chapter 3.

The plant management and corporate analyst at the firm who had control over wage policy spent considerable time studying wage issues, conducting competitive surveys, and interviewing employees and managers. They would gather whatever information was available to them on employee retention, motivation, satisfaction and engagement. This would be used in formulating wage policy and evaluating its success. Wage proposals were made by the individual plants based on their needs and environment and approved by the corporate office. The wage proposals were prepared by the human resource manager on the plant management team after discussions with the plant manager and the plant management team.

4.2.2 Institutional Review Board

Because of the standards surrounding contact with human subjects, this survey and research was reviewed by the University of Utah Institutional Review Board. On June 24, 2010 the IRB ruled that this request 00042056 was exempt under 45 CFR 46.101(b), Categories 2 and 4, from the Federal regulations governing human research. However, it is the policy of the University of Utah that all human subject research which is exempt under this section will nevertheless be conducted in accordance with the Belmont report.

4.2.3 Survey Design

The survey is designed as a cross-sectional survey with ordered categories. A question directed at each economic wage theory is asked about management intent and again the same question is asked about applied effectiveness. The 10 recommendations of Busha and Harter (1980) regarding question structure have been incorporated into the survey design. Designing good questions can be more difficult than it seems. In addition to incorporating Busha and Harter's 10 recommendations the questions were prereviewed orally with a three-member focus group selected from the sample to make sure they were clear and understood. The questions asked the participants are listed in Table 4.1.

Table 4.1 Survey Questions and Economic Wage Theory

SURVEY QUESTION	ECONOMIC WAGE THEORY ADDRESSED
Were the following significant forces in pay setting policy:	
1 Avoiding Unions	Power Relationships
2 Obtaining Loyalty and commitment	Institutional Structures
3 Hiring the best employees	Institutional Structures
4 Sharing the prosperity with employees -Fairness	Institutional Structures
5 Preventing turnover	Efficiency Wage
6 Obtaining extra motivation and effort	Efficiency Wage
7 Making life easier for management and personnel	Agency Theory
Was premium pay effective in achieving the following:	
8 Avoiding Unions	Power Relationships
9 Obtaining Loyalty and commitment	Institutional Structures
10 Hiring above average employees	Institutional Structures
11 Sharing the prosperity with employees -Fairness	Institutional Structures
12 Preventing turnover	Efficiency Wage
13 Obtaining extra motivation and effort	Efficiency Wage
14 Making life easier for management and personnel	Agency Theory
During the 1990s did Management philosophy regarding pay change	
15 Premium pay was seen as successful and increased	Overall Evaluation of Premium Pay per Efficiency Wage
16 Premium pay was seen as unnecessary and decreased	Overall Evaluation of Premium Pay per Efficiency Wage

Answers to these questions are recorded within an ordered category. The answers are coded in number form with 1 being "NO" and 5 being "YES." Clearly the labels are not numbers and there is no clear assertion that numerically the categories are as purely arithmetic as say a temperature scale. However, the 5 ordered categories are presented to the survey participants as a scale with verbal descriptions only provided at the opposites ends of the scale. These form a rational sequence and allow some limited quantitative analysis. We can calculate averages and distributions to represent survey response.

4.2.4 Addressing Inherent Survey Errors

Surveys must be designed to avoid specific errors such as sampling selection error, noncoverage error, nonresponse error and measurement errors.

Since the population is quite small and an attempt is made to survey the entire population the sample selection error is not significant. In general increasing the sample size decreases the sampling error (Cui, 2003). In our case the attempted sample size is 100% minimizing the risk of sample selection error.

There is an issue with noncoverage error. Some of the retired management members cannot be located to include in the survey sample. However, there is no reason to think that the members of the population who can no longer be located have different characteristics from those who have been located. They do not represent a specific class or strata of the population but instead are assumed to be a random part of the population.

The nonresponse error is small. Response rates were managed by using the Total Design Method developed by Don Dillman (1991). This is a comprehensive system used to improve response rates. Using this approach perceived participation costs were minimized using short easy questions and explaining the limited commitment upfront. Perceived rewards were maximized by briefly explaining the possible research benefits. And trust was enhanced by using the name of the University of Utah (Dillman, 1991).

Measurement errors are mistakes made by those taking the survey. Because of the very simple nature of this survey the possibility of measurement errors has been minimized. Also the results appear to be consistent both within and across survey participants.

Sometimes researchers find it necessary to stratify the sample and weight the elements of the sample. Most advanced survey techniques use approaches like this to normalize or adjust sample weights to the assumed population weights. These techniques are not necessary in this research. The only possible way to stratify the sample is by the job that the member of the plant management team held, and this is not necessary. While some members of the team may have had more influence on the pay policy (Plant Manager, Human Resource Manager) all members of the team participated fully in the discussion and had equal information. As a result they should have similar views on the team's motives and policy effectiveness in pay setting policy.

4.2.5 Sample Size Selection

The sample size is a primary factor in understanding the statistical significance of the survey results. Generally surveys try to minimize both errors, alpha (finding a difference that does not actually exist in the population) and beta (failing to find a difference that actually exists in the population) (Peers, 1996). In this research a key impact on sample size is the small size of the population. It is estimated that the population is approximately 40 (N=40). The plant management team is composed of approximately five individuals (plant director, operations manager, human resource manager, finance manager and commercial manager). If during the 10-year study each plant had two individuals in each position the four locations would provide a population of about 40. Because many of these individuals have retired and left the business, only 20 of them can still be located. This limits the sample size due to practical considerations rather than statistical choice. Actual response rates provide only 15 survey results from this sample. A sample of 15 out of a population of 40 is a 38% coverage ratio. While this would be extremely high for most surveys with a population of thousands, given the small population it does not provide the full coverage desired for the general margin of error of 5%.

The actual impact can be calculated using Cochran's sample size formula. This formula is particularly useful for this research because it makes adjustments for small populations (Cochran, 1977).

$$N_0 = \frac{T^2 * SV^2}{(S * AE)^2}$$

N_o is the sample size.

T is the alpha error.

SV is the variance of the scale variable (usually size of the scale divided by 6 for 6 standard deviations)

S is the numerical size of the scale.

AE is the acceptable margin of error from the mean.

This calculation is then adjusted for the small population size per Cochran's 1977 formula.

$$N = \frac{N_0}{(1 - \frac{N_0}{P})}$$

Using the desired 5% alpha error and the standard 5% error for the mean a desired population calculation would be:

$$42 \quad = \frac{1.96^2 * .83^2}{(5 * .05)^2} \qquad 21 = \frac{42}{(1 - \frac{42}{40})}$$

As shown per the Cochran calculation the optimal sample size would be 21. Given the fact that data points have been obtained for only 15 from the estimated population of 40 the error assumption will be higher than the desired 5%. Using the formula with a sample size of 15 will result in an alpha error of 13%. This is substantially higher than the 5% desired a priori but is still workable for inferences made from the survey data.

4.2.6 Survey Results

Table 4.2 provides a summary of survey results. While the averages of many questions were similar there are some unambiguous outliers. Also, by using the confidence interval the questions can all be clearly positioned as either close to yes or no.

The questions about the wage theory of power relationships (1,8) clearly tell us that management was conscious of this issue and felt that premium pay was very

Table 4.2 Summary of Survey Results

SURVEY RESULTS					
				95% Confidence Limit	
QUESTION		Average	Std Error	High	Low
Were the following significant forces in pay setting policy:					
1	Avoiding Unions	4.27	0.228	4.75	3.78
2	Obtaining Loyalty and commitment	4.57	0.173	4.94	4.20
3	Hiring the best employees	4.67	0.159	5.01	4.33
4	Sharing the prosperity with employees -Fairness	3.60	0.289	4.22	2.98
5	Preventing turnover	3.60	0.235	4.10	3.10
6	Obtaining extra motivation and effort	3.33	0.270	3.91	2.76
7	Making life easier for management and personnel	2.07	0.300	2.71	1.43
Was premium pay effective in achieving the following:					
8	Avoiding Unions	4.67	0.159	5.01	4.33
9	Obtaining Loyalty and commitment	3.85	0.274	4.43	3.26
10	Hiring above average employees	4.07	0.228	4.55	3.58
11	Sharing the prosperity with employees -Fairness	3.43	0.327	4.12	2.73
12	Preventing turnover	4.20	0.279	4.80	3.60
13	Obtaining extra motivation and effort	2.53	0.256	3.08	1.99
14	Making life easier for management and personnel	2.20	0.279	2.80	1.60
During the 1990s did Management philosophy regarding pay change					
15	Premium pay was seen as successful and increased	2.80	0.359	3.56	2.04
16	Premium pay was seen as unnecessary and decreased	4.00	0.300	4.64	3.36

effective in the fight to keep unions out. In fact it was one of only two questions with a higher average response in the second set of questions (where management felt premium pay was more effective in achieving the goal) than the first set of questions (where management rated the goal relative to pay setting policy).

The questions about agency theory (7,14) clearly had the lowest scores of all questions. Management did not feel that the nonprofit maximizing goals of management impacted pay setting policy. And in fact many of the ad-hoc comments submitted reiterated the fact that even though pay was high, management tasks were very difficult because employees continued to express demands and voice issues, despite the premium pay.

While turnover issues (questions 5, 12) were not number 1 on the list of pay setting objectives there was solid evidence that management felt the premium was extremely successful in minimizing turnover. This is a version of the efficiency wage hypothesis (see Chapter 2) and holds up to the reasonability test. If the present value of the wage premium is less than the cost of recruiting and training then the efficiency wage is rational. However, because it was rated third to last out of the seven objectives considered, any argument for this as the reason for premium pay is minimized. Management clearly felt that the other issues were stronger forces in selecting premium wage.

Also relative to efficiency wage, management clearly did not feel that premium wage actually achieved increased productivity (shirking model), or even that it was offered in an attempt to obtain better productivity (questions 6,13). This management view confirms the empirical work covered in Chapter III. Management philosophy seems to have changed over time to reflect a belief that premium pay was not worth it (question 16).

Management appears to see all the institutional and cultural factors to be significant (questions 3,4,5,10,11,12). Some of the free form comments made also support the interpretation of the importance of cultural factors, such as "part of an extended family- employment for life - family (owners) wanted long term trusted people - changed paternalism to individualism."

Figure 4.1 shows the survey results with a confidence interval and Figure 4.2 shows the survey results with percentiles.

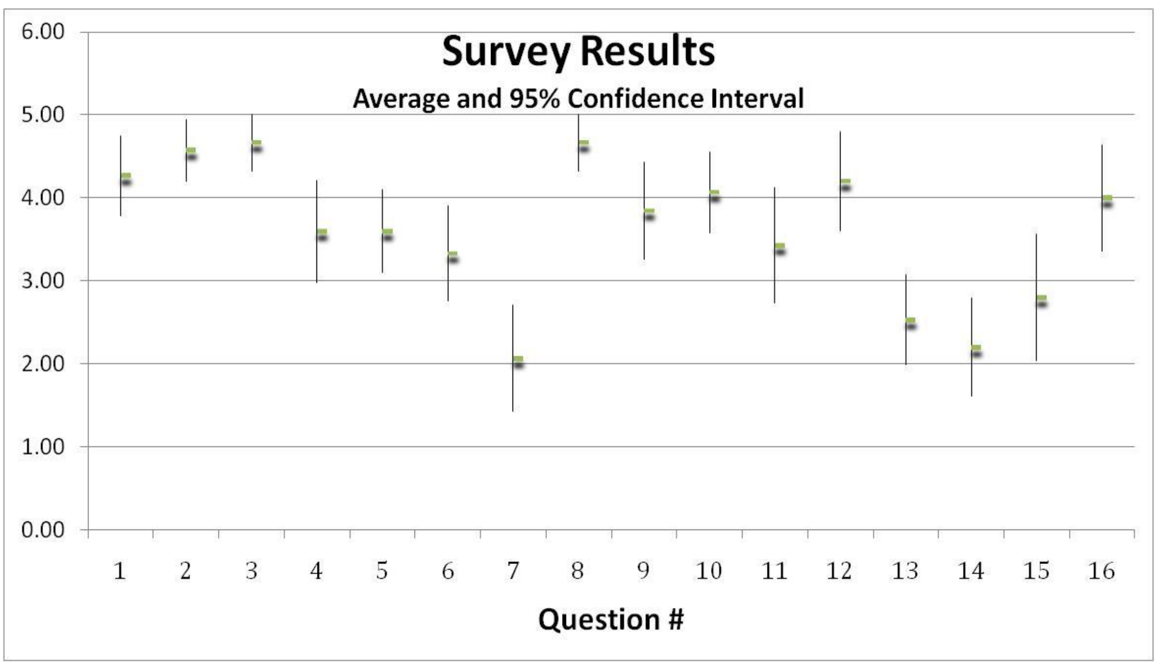


Figure 4.1 Survey Results and Confidence Intervals

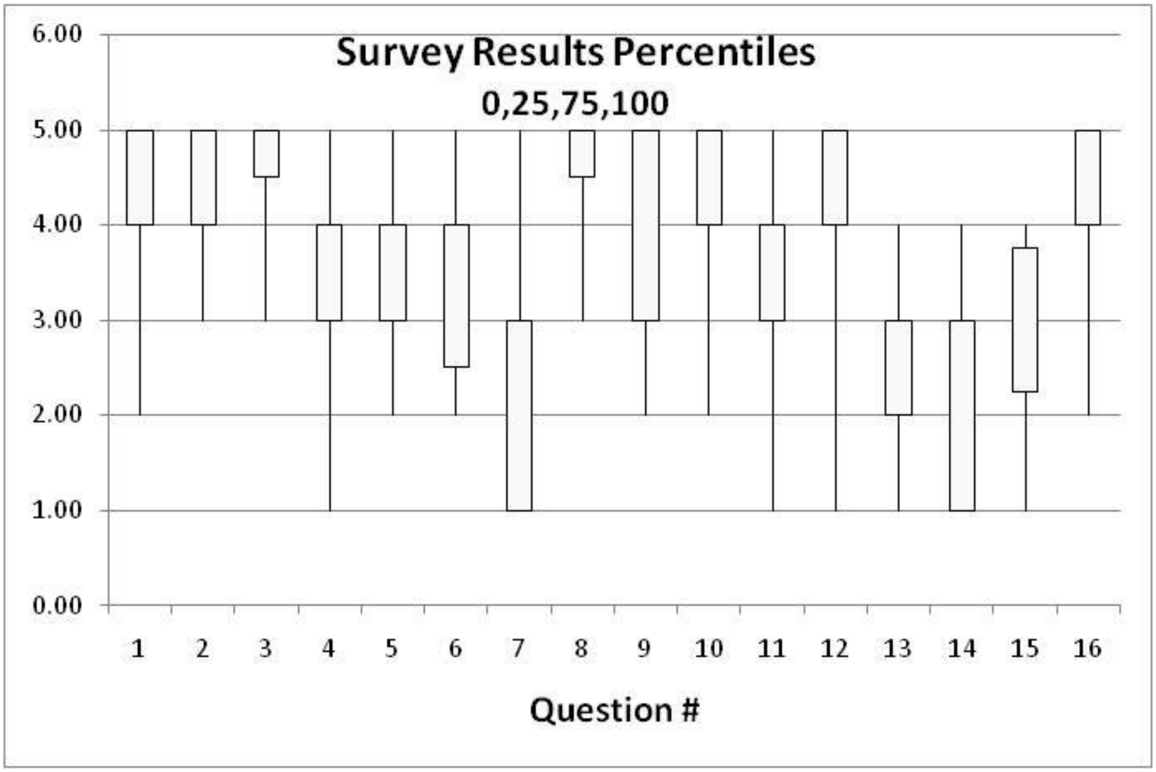


Figure 4.2 Survey Result Percentiles

Figure 4.1 shows the average and a 95% confidence interval. Figure 4.2 shows percentiles. These charts reinforce the comments listed above. In particular the second shows that the bulk of the percentile weights are even more skewed than the

averages, with 11 of the 16 questions having only one tail and 50% of the weights being on a maximum end. Hence the differences between question results are more severe when not considering the outliers.

5 MOTIVATIONAL THEORY AND ITS RELATIONSHIP TO ECONOMIC THEORIES OF WAGE

Economists have historically focused on the relationship between incentives and behavior in order to explain human action. Wages have been considered the incentive identified to motivate work and compensate for the disutility of the task. Wages appropriately play a large role in most economic theory related to the production process. In the modern era, a significant amount of research analyzing motivation (including wage as a factor) has been done by sociologist and organizational behavior specialists. These strains of social science, separate from economics, have produced a large body of work, both theoretical and empirical. The motivational research both supports and discredits certain elements of the economic theories. In this chapter it will be shown that the relationship between wage and motivation which is so important to neoclassical wage theory is seriously challenged by both theoretical and empirical work. In addition much of the organizational and motivation research emphasizes the importance of institutional factors as a trigger and rationale for motivation which is very closely aligned with the institutional wage theories. Most of the contemporary motivational theories have a substantial amount of supporting research (Judge, 2009). They also represent the current state of thinking among top management academics. By understanding and contrasting the motivational research with the economic theories, a more holistic and real world view of the human behavior underlying wage theory can be achieved.

Management behavioral scientists define motivation in a way consistent with effort in the efficiency wage theory. "We define motivation as the processes that account for individual's intensity, direction and persistence of effort toward attaining a goal" (Mitchell, 1997, p. 61) . With motivation (intensity, direction and persistence) an employee will be capable of increasing output (the goal). This definition is reminiscent of the efficiency wage relationship between effort and output Output = $F(e(\mathrm{w}))$.

5.1 Background

As a background to understanding motivational theories' relationship to the economic theories of wage, two studies will be helpful in building a foundation. The first, a framework by Benabou and Triole and the second, an empirical research study by Ingalens and Roussel.

Benabou and Triole (2003) develop an equation that shows how multiple elements work together effecting motivation. The equation relies on three variables, β, the specific parameters of the work task and the ability of the employee, *p,* the policy of management, and *e,* the effort of the employee. These three variables can determine both the manager's and the employee's payoff. Payoff is the utility achieved by either a manager or employee as a result of their actions. The expected value of the manager's payoff would be shown as follows:

$$E[\, U\ (\beta, e^{*}\left(p, \check{\beta}(\sigma, \mathrm{p})\right), \mathrm{p})|\beta]$$

Here U is the utility (payoff) to the employer, and sigma σ is the parameter of asynchronous information. Only a portion of the full fixed information β is assumed to have been signaled to the employee about the task and the employee's abilities. $\check{\beta}$ is the employee's interpretation of β given the portion (σ) of information signaled and his interpretation of the policy adopted by the manager. e^{*} is the employee's optimal effort (from his point of view) and depends on the policy and his interpretation of the work parameters and his ability. When maximized, the result will have three important terms.

$$E\left[\underbrace{\frac{dU}{dp}}_{\text{First}} + \underbrace{\frac{dU}{de^{*}} \cdot \frac{de^{*}}{dp}}_{\text{Second}} + \underbrace{\frac{dU}{de^{*}} \cdot \frac{de^{*}}{d\check{\beta}} \cdot \frac{d\check{\beta}}{dp}}_{\text{Third}} \middle| \beta\right] = 0$$

Terms: First Second Third

The first term represents the cost to the manager of the policy, for example the higher wage. The second term represents the direct impact of the policy on the employee's behavior. It is within this term that efficiency wage effects could materialize as policy (wage and other factors) drives effort. The third term is about employee perception of management motive which could be favorable or unfavorable. The employee will interpret the policy based on his or her view of the managers' objectives. Generally the first term is assumed to be negative as the manager has to give something to the employee. The second term is assumed to be positive as the employee responds to the management's policy. The third term could be of either sign based on the employee's positive or negative perceptions about management motive and as a result swing the overall result positive or negative. For example, based on the way it is communicated, an employee may interpret an assignment to work overtime as a punishment for being inefficient or as a reward for being the most able to contribute. This equation is used to outline several conditions.

1. Employee sensitivity to and perception of performance incentives can negatively impact perceptions about the task and overwhelm the direct motivational impacts of the policy.

2. Incentives can be weak motivators in the short run and negative in the long run and they impact employee perceptions (Benabou & Triole, 2003).

3. Ability β and effort e^* can serve as complements and someone with perceived greater ability could reduce effort in the presences of a pass - fail outcome.

These conclusions set the stage for the following discussion in this chapter of the limited role of wage and the importance of policy and culture beyond wage. It can also apply directly to the Mars data used in this research, given that everyone is paid on the same scale so pass -fail are the only likely results of effort. Since output is only measured for the team, this allows the perception of ability (true or not) to be a substitute for reduced effort (see condition 3 above).

In the second background research Igalens and Roussel (1999) published a study on the relationship between pay and work motivation. Their field test and empirical research was based on a framework using the expectancy theory. They collected 566 surveys from employees in France, but more importantly, 297 of these surveys were from nonexempt (eligible for overtime) employees which are consistent with the 5000 nonexempt Mars, Inc. employees included in this research.

Igalens and Roussel tested, using the French worker survey, whether fixed pay, flexible pay and benefits were related to motivation and concluded that the valence attached to fixed pay, flexible pay and benefits did not influence work motivation. The results from Igalens and Roussel are consistent with the results of the direct production functions empirically tested in this research (see Chapter 3). For the nonexempt associates the relationship of fixed pay to motivation was negative and the relationship of variable pay and benefits to motivation was insignificant.

5.2 Neoclassical Wage Theory

Neoclassical wage theory rests on wage being the driving force behind motivation. It is through wage that the negatives associated with work are overcome and justify the tradeoff with leisure. The efficiency wage theory postulates that through additional wage extra effort is generated and incremental output is achieved. Both the early content motivational theories and the cognitive theories challenge this assumption.

Early theories on motivation such as Maslow's hierarchy of needs (Maslow, 1954) and Herzberg's two-factor theory (Herzberg, Mausner, & Snyderman, 1959) were largely focused on content. Maslow's well known theory separated needs into lower order needs and higher order needs. Herzberg analyzed the factors that impact job satisfaction, and separated the factors between those that lead to satisfaction and those that lead to dissatisfaction. Even though these two theories are some of the original motivation theories, the content elements are still included within the most contemporary theories.

A major point that is relevant from these early motivational theories is that wages are a small part of motivation. Relative to Maslow's hierarchy, wages would fit largely in the lowest need state - physiological needs. Herzberg calls this level of need hygiene factors and completely separates hygiene factors from what he calls motivational factors. Of the 16 factors that Herzberg identifies as contributing to job satisfaction or dissatisfaction salary ends up only being a minor one (Herzberg, 2003). If pay is a minor factor affecting motivation, links between wage and effort as identified by the efficiency wage model become suspect.

The factors that Herzberg list as being most important relative to motivation include relationship with supervisor, company policy and administration and recognition and achievement. These factors would fit much better with the structural arguments supporting the institutional economic theories of wage because the institutional theories are based on policy and cultural and social norms. Even these earlier motivational theories recognized the role of group dynamics and a need to see employees as complex individuals with many motivational influences.

5.2.1 Cognitive Evaluation Theory

Cognitive Evaluation Theory proposes that extrinsic rewards, such as pay, can actually reduce the intrinsic reward of the work, thereby potentially reducing motivation (effort). While this is somewhat counter intuitive it has been backed up by a large number of studies. (Deci, 1975; Hall, 1995; Deci, Koestner, & Ryan, 1999).

Possible reasons have been suggested why this might occur. These reasons include the idea that extrinsic rewards give an individual a loss of personal control along with the idea that an individual may perceive that if higher extrinsic rewards are provided, they must be required; therefore the previous level of intrinsic rewards must not be valid and are therefore reduced. The cognitive theory has major implications for management and pay setting policy because of implying that any motivational impact of a pay increase might be more than offset by a reduction in personal motivating factors. If taken to an extreme the theory could even suggest that workers should pay to increase their personal work satisfaction.

Relative to the economic wage theories, cognitive theory would of course be at odds with neoclassical theory and efficiency wage theory. Perhaps cognitive theory would fit better with Marx's view of work alienation and human desires for fulfilling work because Marx stresses a natural intrinsic motivation which he sees as shattered by the capitalist system (Bertell, 1971). Because of its controversial conclusions it is not surprising that this theory has been attacked in both methodology and interpretations. These attacks have raised some substantial questions. Today we understand that there are many underlying factors for motivation and the framework proposed by Cognitive Evaluation Theory may or may not appropriately apply to a situation depending on specific circumstances (Judge, 2009). However it has been observed per the studies referenced previously that there are occasions where the introduction of extrinsic rewards such as increased pay, can undermine the intrinsic motivation and end up reducing effort.

5.3 Institutional Wage Theory

Institutional theories on wage rest on historical processes and organizational practices. These include among a wide range of additional factors, things like bureaucratic hiring rules, social job "contracts," manager moral responsibility, legal wage and work laws, and firm specific training and knowledge (see Chapter 2). Within this theory wages and effort are not always directly connected. One can find many parallels with the wide range of impacting factors that institutional economic thought applies to wages and the factors which modern motivational theories apply to motivation. The relationship of modern motivational theories to institutional wage theory will be explored through Expectancy Theory which serves as an umbrella theory of many current theories on motivation.

5.3.1 Expectancy Theory

One of the most widely held explanations of motivation is Victor Vrom's expectancy theory published in 1964. Expectancy theory can be considered an umbrella theory because many of the other contemporary theories on motivation fit within the three relationships on which expectancy theory is built. By describing this theory the parallels with institutional economic thought can be pointed out. It is also highly supported by the empirical research (Judge, 2009).

Expectancy theory proposes that motivation depends on three factors. Vroom refers to these three major expectancy theory factors or variables as expectancy, instrumentality and valence. (Vroom, 1964). The three relationship variables are multiplicative. If any one of them is zero, total motivation will be zero, and if any one of them increases it will increase motivation.

The first is the expectation that effort will produce result. This is supported by the theory of self-efficacy (Bandura, 1997), the internal belief in personal capabilities. If an individual does not have the capabilities to perform at a high level, no amount of effort will result in high performance. Rational individuals recognize this connection and will put forth effort only where they think it will be effective. This expectation also requires a belief that the organization or system can recognize the extra performance, that it will be visible. For example, extra effort put into the creation of a contingency plan that will likely never be reviewed or used is not likely to be recognized by an organization. Relative to institutional wage theory the level of visibility of both effort and results is highly reliant upon the institutional processes for monitoring and measuring. Firm specific knowledge and culture will also influence the expectation that effort will produce a result.

The second factor in this theory is the expectation that performance will produce a reward. The motivational theory of equity (Adams, 1965) fits into the expectancy theory here. Many employees see the performance reward relationship as weak. They believe that social skills, length of service or race and ethnicity could influence rewards just as much or more than performance. This relates directly to the case study in this research. If all members of a team are paid the same wage, as was the case at Mars, but are seen to put forth different amounts of effort, team members would perceive the situation as unfair. This is not motivating and can create anger and guilt. The strength of the performance reward relationship will depend upon institutional factors such as pay policies, wage laws and cultural norms.

The third factor is the expectation that the reward will be personally satisfying. The motivational theory of reinforcement (Komaki, Coombs, & Schepman, 1996) fits into this factor. If an employee wants recognition but instead gets a pay raise or wants a pay raise but instead gets rewarded with more work, the reward will not be satisfying. It also raises the question, "Do all employees want the same thing?" In economics the simplifying assumption of homogeneity is regularly used, and in business. most managers neither have the authority nor practical capability to individualize rewards. The recognition of the importance of rewards beyond pay alone further aligns expectancy theory with institutional wage theory rather than neoclassical wage theory.

5.4 The Relationship Between Motivational Theory and Economic Wage Theories

There are a many motivational theories which have been supported with empirical research. From this it is clear that motivational theory is not simple. Labor does not respond uniformly to a single variable, even one as powerful as wage.

Within economics the effort is often made to isolate the impact of individual variables with an assumption of ceteris paribus, holding everything else constant. But the reality is that there is never a case where "everything else" is held constant. The state of flux and the number of variables and interactions involved with motivating employees to extend additional effort make such an assumption unreasonable. It is most practical to approach motivation with an umbrella theory such as expectancy theory and then relate the underlying principles exposed to the economic theories. This relationship is demonstrated in Figure 5.1.

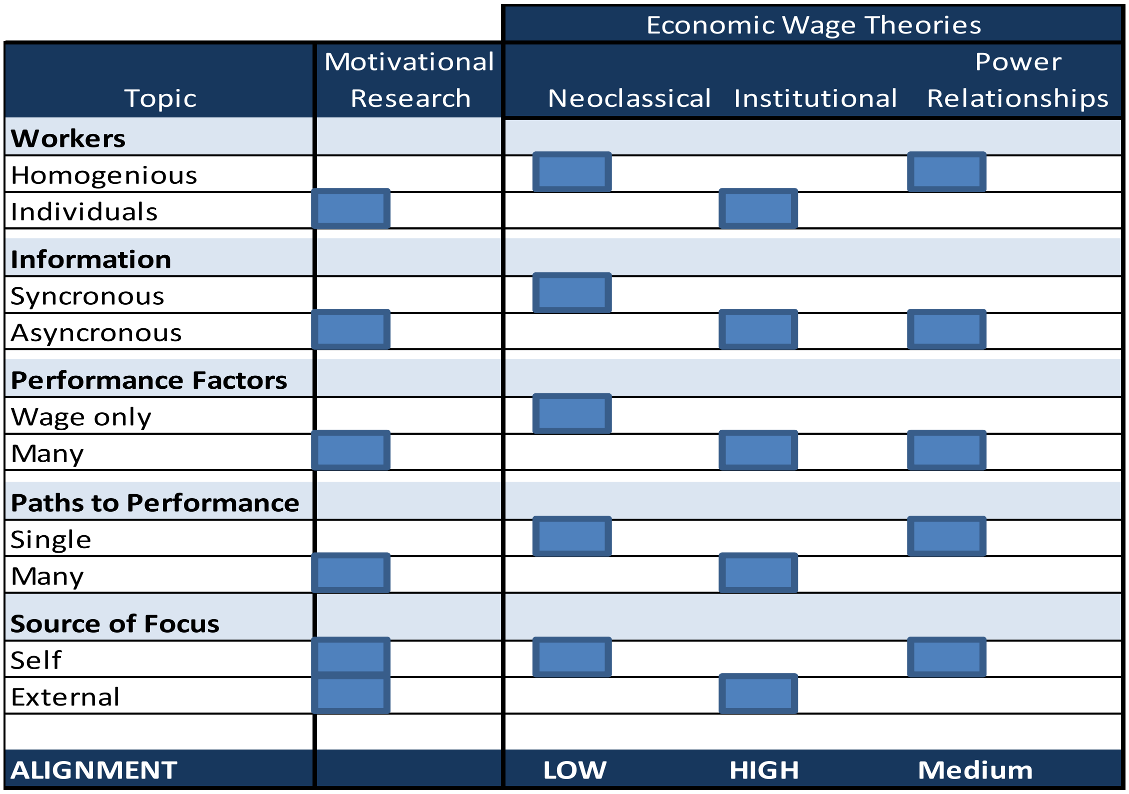


Figure 5.1 Relationship Between Motivational and Economic Theories

Figure 5.1 shows a number of descriptive elements summarizing motivational theory and the three categories of economic wage theory. Workers are seen within motivational theory as distinct individuals and are sometimes classified by different types, such as high achievers, and others, as goal directed individuals. Within the neoclassical wage theory workers are seen as a homogenous rational man responding identically to each other. Information is required for the rationality imposed by neoclassical theory. However, within motivational theories and the institutional and power relationship wage theory, information is not always available or always shared. Perceptions are built on partial information. Much motivational theory explores many different drivers for motivation, while this is consistent with the framework for institutional wage theory it is inconsistent with both neoclassical theory and the incentives behind power relationships. In addition to being distinct individuals, workers have, within motivational theory many different paths to motivation (Judge, 2009). And finally, motivational theory describes that factors both intrinsic and extrinsic can be the primary source for motivation. The existence of multiple factors is consistent with institutional theory where both social norms and external rewards are recognized, but not with neoclassical theory where only external rewards are paramount.

As demonstrated in Figure 5.1 Institutional Wage theory has a higher alignment with motivational theory than do either neoclassical or power relationships. As a result the significant empirical support which has been obtained for modern motivational theories adds indirect support in favor of the institutional wage theories over neoclassical and power relationships.

Table 5.1 Theory Alignment

Economic Wage Theory	**Motivational Theory**
Neoclassical Theory	Reinforcement,
Institutional Theory	Self efficacy Equity Two Factor Maslow Goal setting Expectancy
Power relationships	Organizational Justice

In Table 5.1 each key motivational theory is assigned to the economic wage theory to which it is most closely aligned. There are some connections with each of the economic theories of wage; however there is an abundance of relationships between accepted motivational theory and practice with the institutional theory of wage.

Even if there were a functional relationship between the independent variables such as the various elements of compensation (more than wage), the various factors impacting job satisfaction, and a dependent variable of motivation (effort), there is no clear agreement on the nature of this relationship. This is clearly demonstrated by the variety of theories just discussed and calls into question the veracity of the proposed relationship at the heart of the efficiency wage theory.

This chapter shows that the organizational behavior work relating to motivation provides both theoretical and empirical support for certain economic theories of wage. The research tends to argue against the neoclassical wage theory because it hypothesizes that wage is weakly or even negatively related to effort. Also, there is a plethora of alternative input factors, other than wage, which impact performance to a greater degree than do wages. The described motivational theories provide a strong support to the ideas proposed in institutional wage theory. They conclude that a number of job design and company policy issues, as well as social norms and legal structure provide significant motivational impact and as a result largely determine employee effort and even participation in the work force.

6. CONCLUSIONS

6.1 Conclusion I

This study has resulted in conclusions that are different from most of the published work on efficiency wage. The shirking model of efficiency wage has long been accepted because of the logical and appealing theoretical formulations and because of the indirect empirical work using supervision and industry wage relationships. Efficiency wage has also been shown to be very popular in terms of justifying real world observations such as wage variability, sticky wages and involuntary unemployment. However, not all research does support the shirking model efficiency wage hypothesis. In 1987 during the height of efficiency wage academic work Jonathan Leonard (1987) conducted a study at the level of the firm. This was the first study that tested the level of supervisory intensity and the level of wage at the firm level. The data came from a 1982 survey of 200 plants and 70,000 employees in France. He states that "Little evidence is found to support either version of the Efficiency Wage Model." (p. 152)

Similar to Leonard's work, this research tests the shirking model of efficiency wage directly at a plant level, but it does so by econometrically fitting a microlevel production function including wage premium as an independent variable. The empirical results taken by production line, by plant, for specific years and across time periods show no support for the shirking model of efficiency wage (Chapter 3).

The econometric results are backed up by the management survey (Chapter 4) and by the body of organization behavior work (Chapter 5). As a result the first conclusion that can be drawn for this research is:

Conclusion I. *There are production environments and time periods for which the shirking model of the efficiency wage theory does not hold. In these cases increased wage does not result in additional production.*

This conclusion challenges not only the efficiency wage theory but calls into question several very important elements of the neoclassical paradigm. If efficiency wage is not generally valid then why do wages include so much variability for the same job and same geographical location, and how do we explain involuntary unemployment and sticky wages? Central to neoclassical theory is the assertion that the wage level adjusts and determines the size of the work force as a result of the labor-leisure trade off. The size of the work force then determines the supply output level of production. If labor levels are not directly tied to wage levels, then much of the underlying framework of neoclassical theory is suspect. As a result, the equilibrium adjustment process (using wage level changes) is also called into question.

Empirically, the result of this research is only applicable to the specific locations and dates of the study. However, there is some evidence that similar results are more general and are not simply limited to the specific case study in this research, as is shown by the wide spread work from organizational behavior scientists and motivational theorist (as reviewed in Chapter 5), and in additional results such as the research by Jonathan Leonard which challenge the core efficiency wage hypothesis.

6.2 Conclusion II

The results of the survey (Chapter 4) highlight that wage policy was both intended to help avoid unionization and also that it was quite effective in doing so. The intent to avoid unions is consistent with the private ownership culture identified in Chapter 4. Union advocates have identified what they call the "free rider" problem of nonunion employees receiving benefits for which their union counterparts bargain. In this case the "free rider" problem is demonstrated by management having an incentive to match high union wages and avoid the organizational and power issues associated with a union. Booth (2004) has explained that the "free rider" problem is a reality despite the documented wage gap between union and nonunion workers. And paying high wages has been documented as a practice for nonunion companies in avoiding union organizing (Ohingra, 1969). While measurements around the union and nonunion wage gap vary, the range over the time period of this study is 15.5% (Blanchflower, 1999) to 25% (Bratsberg & Ragan, 2002). The wage premiums included in this study range from 16% to 60%. These premiums would clearly be effective in countering the need for union pay at 15% to 25%. However, because they are often so much higher than the union premium, this argument cannot justify the full amount of the wage premiums in this study. Clearly other motivating factors also contribute to the premium pay. While avoiding unions was not the top item in the survey in terms of management purpose, as number three it was clearly an important part of the consideration in setting pay policy. And in terms of effectiveness, management clearly viewed the high wage as more effective in avoiding unions than any of the other objectives associated with premium pay.

Conclusion II. *Management considered their desire to avoid unions as a motivator in setting the premium pay. They viewed the premium pay as very effective in avoiding union organizing.*

The power the employees had to threaten a union was a key motivator for premium pay as suggested by the power relationship wage theory. During the 1990s the influence of unions in U.S. private companies was reduced and there was increased labor insecurity due to globalization, especially within manufacturing. This change represented a shift in power within the labor employer relationship and per the power relationship wage theory would lead to a reduction in premium wages. This is consistent with the results of the management survey which report that premium pay was increasingly seen as less necessary.

6.3 Conclusion III

For Mars, the strong cultural environment seems to be the dominant factor influencing overall wage levels and policy. This is backed up by the discussion of private ownership and company objectives and culture in Chapter 4 which enumerated their influences on wage setting policy. The strong influence of the cultural environment is also supported by the management survey where there is a strong management view that culture played a large role in determining pay policy. The eight survey questions about institutional arrangements (2,3,4,5,9,10,11,12) were all viewed as top reasons for the pay policy. The survey shows that management believes that pay policy has been very effective in supporting the cultural objectives.

Conclusion III. *At Mars, the cultural and institutional environment provides the dominant factors influencing wage policy and practice.*

This conclusion is consistent with and supportive of much of the work within institutional wage theory. The corporate culture leads to the development of corporate policy which establishes the firm employee relationship. This leads to the implicit firm employee contract which guides wage policy and employee satisfaction, engagement and effort.

6.4 Conclusion IV

In Chapter 5 the organizational behavior work relating to motivation provides both theoretical and empirical support for certain economic theories of wage. This support tends to argue against the neoclassical wage theory because the organizational behavior work hypothesizes that wage is weakly or even negatively related to effort. In addition, these theories provide a plethora of alternative input factors that would impact performance even more so than wages. While challenging the neoclassical theories of wage the motivational theories do provide a strong support to the ideas proposed in institutional wage theory. They conclude that a number of job design and company policy issues, as well as social norms and legal structure will provide significant motivational impact and as a result largely determine employee effort and even participation in the work force. These factors take the place that wage takes in the neoclassical wage theory. These factors are also consistent with the kinds of things that the institutional wage theory hypothesizes determines wage.

Conclusion IV. *Motivational theory provides a strong body of theoretical and empirical research, that confirm the results of this research and supports the institutional theory of wages.*

6.5 Implications

The conclusions of this research have important implications for both managers of employees and executives who set corporate policy. In addition there are policy implications for government agencies and legislative bodies that attempt to influence wage practices.

If firms are to achieve efficient output, they need employee effort. Employee effort cannot be achieved without a significant investment in culture and institutions designed to support motivation. Wages alone are a poor motivator, and as demonstrated are only loosely connected to effort. The motivational forces of wages alone are unlikely to overcome any negative impacts of institutional frameworks or social contracts. Managers and corporate policy implementers must dedicate significant strategic effort in areas such as job design, team empowerment and other cultural engagement issues if they are to elicit employee effort. Corporations must also make sure managers are trained to support the development of effective cultures and employee engagement. Corporations should not resort to wage adjustments as a primary lever to solve human resource problems.

Government agency and legislative bodies often set policy to regulate labor markets and establish wage levels. In doing so these governmental institutions should look at managing the institutional "rules of the game" rather than supporting the efficiency ideals of a purely laissez-faire approach. As demonstrated in this research, with the challenge to neoclassical wage theory and the support of institutional wage factors, a focus on institutions such as minimum wage, work rules and tax structures can provide a stronger influence on wage development and income distribution than the market. Given a supportive cultural environment these institutional factors can also provide greater motivation and elicit increased employee effort and production than can market wage mechanisms. Governments, if they choose to, can also implement policies that support the development of market structures that favor the characteristics of firms which pay high wages. These characteristics are things such a product market concentration, capital intensity, unionism and overall size of the firm. Governments can also implement policies which lead to the balkanization or reunification of the various labor markets relative to licensing and training requirements as well as promoting mobility.

6.6 Additional Research

Four questions requiring additional research come out of this study.

First, this study was limited to four plants in four geographies. Additional research should be done to broaden the base of these results and prove more general conclusions. This additional research could be done at a plant or company level in additional industries and geographies. The additional research might also be done on an industry or market wide area if direct productivity comparisons were identified such as small cities with similar output and production technology.

Second, given a tendency for the effort relative to wage to experience diminishing returns and become flat and because output related to effort will be also experience diminishing returns and become flat, it can be argued that these two curves combined ($O=f(e(w))$) could result in a large horizontal relationship between wages and output. If this were the case it could make efficiency wage theory ineffective. This possibility is discussed in Appendix E. Efficiency wage theory requires the relationship of increasing output to wages so that the wage-effort relationship can be maximized (see the Solow condition in Chapter 2). Empirical tests of these relationships would provide additional understanding of efficiency wage theories and the wage output relationship.

Third, a motivational model could be built in multidimensional space with dimensions defined by factors of motivation. Into this space a budget constraint and an indifference curve could be placed. The budget constraint would show the trade off in costs between various motivating factors (wage and nonwage). The indifference curve would show the level of motivation achieved with different mixes of the motivational factors. The slopes of the curves would determine what mix of factors should be employed to maximize motivation given the budget constraints. Empirical research around the slopes of these curves would be helpful in understanding how to maximize motivation.

Fourth, institutional factors are broad and varied. Most economic work on institutional factors is at a macro or industry level addressing capital intensity, unionization rates and public policy. Research should be conducted to determine at a firm level what policies impact wage and motivation. This could include the significant cultural examples highlighted in the Mars, Inc. discussion in Chapter 4. Among others these included private ownership, the desire for long-term employee relationships, a paternalistic and egalitarian organization, a desire to accept and focus on technological improvements, a working relationship between owners and employees and a serious desire to avoid unions. The stylized facts relating to the institutions and culture of highly motivated organizations would provide a road map to further understanding of motivational theory and to improving motivation in other firms.

APPENDIX A

PRODUCTION DATA

Table A1 Albany Plant Production Data

			Act	Act	Act	Act	Act	Act	Act	Act	Act	Plan
Plant	Line	data	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Albany	Baked Filled Ln 1	Volume	9.5	7.8	7.7	13.3	13.1	12.7	14.8	15.1	16.4	17.1
Albany	Baked Filled Ln 1	SOC		14	16.1	14.7	15.5	14.7	15	16.1	19.7	22.9
Albany	Baked Filled Ln 1	Headcount	136	142	132	175	167	164	161	162	169	151
Albany	Baked Filled Ln 1	Line Assets	25.7	29.9	25.1	43.7	39.3	33.1	33.6	33.7	33.5	38.1
Albany												
Albany	Baked Filled Ln 2	Volume	6.6	5.4	5.4	0						
Albany	Baked Filled Ln 2	SOC		10.6	10.3	0						
Albany	Baked Filled Ln 2	Headcount	129	136	120	0						
Albany	Baked Filled Ln 2	Line Assets	25.6	27.4	22.1	0						
Albany												
Albany	Fruit Twist	Volume					6.5	4.4	3.9	3.4	3.6	2.6
Albany	Fruit Twist	SOC				5.5	11.1	16.1	15.3	16.7	11	12.7
Albany	Fruit Twist	Headcount					171	76	46	34	75	51
Albany	Fruit Twist	Line Assets				8.8	11.9	13.4	16.6	17.1	18.1	18.9
Albany												
Albany	Peanut Process	Volume	35.9	29.6	30.2	34.6	34	32.6	32	32.6	33.1	33.3
Albany	Peanut Process	SOC		55.1	58.3	61.6	64.5	59.1	55.8	56.2	62	67.3
Albany	Peanut Process	Headcount	102	98	96	78	79	80	85	83	68	66
Albany	Peanut Process	Line Assets	24.5	25.1	20.4	24.6	24.1	25	26.1	26.6	28.7	19.2

Table A2 Chicago Plant Production Data

			Act	Act	Act	Act	Act	Act	Act	Act	Act	Plan
Plant	Line	data	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Chicago	Filled Bar Ln 1 Fs/S	Volume	32.6	32.2	30.7	26.4	21.3	24.3	22.4	17.9	21.6	21.4
Chicago	Filled Bar Ln 1 Fs/S	SOC		36.9	39	36.9	39.3	42.3	42.2	49.5	46.1	47.1
Chicago	Filled Bar Ln 1 Fs/S	Headcount	214	230	183	159	135	134	118	110	128	99
Chicago	Filled Bar Ln 1 Fs/S	Line Assets	43.4	43.7	33.1	32.4	27.1	26.4	26.1	20.9	20.3	20.3
Chicago												
Chicago	Filled Bar Ln 2 Sng	Volume	48.3	37.3	32.3	31.5	36.1	32.1	33.4	28	29.2	26.7
Chicago	Filled Bar Ln 2 Sng	SOC		48.6	46.8	49.9	55	56.3	50.1	57.4	51.7	52.9
Chicago	Filled Bar Ln 2 Sng	Headcount	168	170	143	128	127	123	115	107	113	98
Chicago	Filled Bar Ln 2 Sng	Line Assets	46.4	43.6	33.2	33.2	24.7	25.7	26.1	21.1	20.9	21
Chicago												
Chicago	Filled Bar Ln 3 Snck	Volume	13.8	18.4	20.5	22.8	16.8	12.2	10.6	13.4	9.4	12.9
Chicago	Filled Bar Ln 3 Snck	SOC		19.9	20.5	22.8	28	28.6	22.1	22.7	20.2	21.2
Chicago	Filled Bar Ln 3 Snck	Headcount	140	192	159	162	111	96	91	69	67	57
Chicago	Filled Bar Ln 3 Snck	Line Assets	20.5	18.8	17	19.3	31.2	26.3	31	22.3	20.7	20.4
Chicago												
Chicago	Filled Bar Ln 9 Sngl	Volume	11.5	4.2	0	0						
Chicago	Filled Bar Ln 9 Sngl	SOC		12	0							
Chicago	Filled Bar Ln 9 Sngl	Headcount	141	95	0	0						
Chicago	Filled Bar Ln 9 Sngl	Line Assets	27.8	27.5	0	0						
Chicago												
Chicago	Line 4 munch	Volume	0.7	1	0.9	0.9	1	0.9	1.1	1	0.8	0.8
Chicago	Line 4 munch	SOC		2.9	2.9	3.4	3.4	3.3	3.4	3.9	3.9	3.9
Chicago	Line 4 munch	Headcount	14	8	3	12	24	21	18	20	14	12
Chicago	Line 4 munch	Line Assets	1.6	1.8	1.4	1.4	1.4	1.2	1.2	1.3	1.2	1.2
Chicago												
Chicago	Chocolate Plant	Volume	52.1	51.5	50.3	47.1	46.6	44.2	44.4	47.3	44.6	44.1
Chicago	Chocolate Plant	SOC		80.1	74.7	81.1	78.2	80	59.9	80.2	90.5	77.1
Chicago	Chocolate Plant	Headcount	124	109	117	97	80	77	86	106	110	108
Chicago	Chocolate Plant	Line Assets	51.8	50.2	40.1	39.9	37.6	36.9	37.4	26.5	26.1	31.5

Table A3 Cleveland Plant Production Data

			Act	Act	Act	Act	Act	Act	Act	Act	Act	Plan
Plant	Line	data	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Cleveland	Flex Line	Volume	16.5	16.3	20.4	23.7	32.1	29	34.9	26	22.1	21.6
Cleveland	Flex Line	SOC		19.3	20.4	23.7	33.5	38.3	42.9	42.9	28.2	32.1
Cleveland	Flex Line	Headcount	87	85	80	80	79	115	123	128	143	149
Cleveland	Flex Line	Line Assets	44	45.2	41.8	40.7	39.3	50.2	55.3	57	58	63.9
Cleveland												
Cleveland	International	Volume	3.5	3.4	4.2	5.3	5.3	3.8	1.7	1.6	2.4	1.6
Cleveland	International	SOC		4.2	4.2	5.5	5.5	5.7	4.9	4.9	3.8	5
Cleveland	International	Headcount	42	55	49	64	42	33	23	8	14	14
Cleveland	International	Line Assets	10.1	10.4	8.7	9.9	10.3	9.8	9.7	9.7	9.9	9.9
Cleveland												
Cleveland	M&M Peanut	Volume	30.1	32.8	30.3	30.2	31.6	33.3	34.9	34.3	35.6	35.1
Cleveland	M&M Peanut	SOC		32.7	30.3	30.2	40.1	40.8	38.4	38.4	37.5	37.9
Cleveland	M&M Peanut	Headcount	147	130	133	127	131	125	132	130	129	136
Cleveland	M&M Peanut	Line Assets	39.2	40.5	32.2	31.7	31.3	31.4	32	32.9	34.9	36.7
Cleveland												
Cleveland	M&M Plain	Volume	28.2	32.9	32	33	35.9	41.3	49.9	45.2	45.9	44.4
Cleveland	M&M Plain	SOC		33	32	33	52.7	64.6	60.6	60.6	47.8	55.5
Cleveland	M&M Plain	Headcount	142	130	136	130	136	149	193	186	181	182
Cleveland	M&M Plain	Line Assets	41.4	42.7	34.1	33.6	33.4	37.7	46.4	48.8	51.3	53.3
Cleveland												
Cleveland	Twix I	Volume	4.8	24.8	33.3	27.2	27.5	25.3	27	30.7	28.7	29.4
Cleveland	Twix I	SOC		27	33.3	32.1	40.7	38.5	38.4	38.4	32.4	39.7
Cleveland	Twix I	Headcount	99	217	188	150	135	121	108	135	144	143
Cleveland	Twix I	Line Assets	38.4	40.3	33.5	33.7	34	34.6	32.9	33	33.2	35.2
Cleveland												
Cleveland	Twix II	Volume			1.9	6.2	7.6	7	8	10.4	11.4	10.8
Cleveland	Twix II	SOC			4.3	10.2	17	16.4	13.8	13.8	13.2	16.6
Cleveland	Twix II	Headcount			45	87	85	90	80	96	99	99
Cleveland	Twix II	Line Assets			12.7	14.4	16.5	18.3	17	17.1	17.6	19.7
Cleveland												
Cleveland	chocolate Plant	Volume	46.8	53.3	52.3	58.2	65.6	63.9	69.1	65.7	64.1	67.9
Cleveland	chocolate Plant	SOC		97.9	97.9	114.5	122.1	120.8	101.7	101.7	105.5	102.9
Cleveland	chocolate Plant	Headcount	28	37	34	28	28	31	33	32	37	45
Cleveland	chocolate Plant	Line Assets	20	20.9	16.9	16.3	15.3	15.5	15.6	16.1	17.9	19

Table A4 Waco Plant Production Data

			Act	Act	Act	Act	Act	Act	Act	Act	Act	Plan
Plant	Line	data	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
WACO	Line 1	Volume			12	20	26.6	14.5	17.2	21.5	22.9	20.6
WACO	Line 1	SOC			12	30.4	34.2	32.4	35.9	28.8	28.6	30.9
WACO	Line 1	Headcount			165	174	160	111	111	142	144	121
WACO	Line 1	Line Assets			20.8	25.7	25.6	26.7	26.9	30.9	31.6	34
WACO												
WACO	Twix old Line1	Volume	19.6	8.7	0	0						
WACO	Twix old Line1	SOC		16.4	0							
WACO	Twix old Line1	Headcount	123	120	0	0						
WACO	Twix old Line1	Line Assets	35.3	33	0	0						
WACO												
WACO	Line 2 Snickers	Volume	73.5	63.4	56.4	60.3	62.1	58.5	66.6	65.6	67.3	67.8
WACO	Line 2 Snickers	SOC		90.5	89.7	87.2	94.4	91.8	94.1	91.6	91.6	95.3
WACO	Line 2 Snickers	Headcount	225	194	163	143	145	132	143	146	147	136
WACO	Line 2 Snickers	Line Assets	55.1	39.3	25.7	24	23.6	25.2	25.4	25.8	25.7	27.4
WACO												
WACO	Starburst	Volume	19.8	26.4	27.6	31.3	35.5	33.3	35.6	33.1	35.7	34.2
WACO	Starburst	SOC		27.6	29.9	32.4	47.8	41.5	42.2	45.9	47	52
WACO	Starburst	Headcount	221	249	261	292	307	288	279	212	198	224
WACO	Starburst	Line Assets	37.1	31.3	34.1	36.6	37.5	48.3	53.9	55	46.9	58.4
WACO												
WACO	Skittles	Volume	28	31.8	34.2	37.7	42.6	41.1	40	41.3	45.8	37.8
WACO	Skittles	SOC		32.1	39.4	43.8	60.3	60.2	51.1	59.5	59.4	59.6
WACO	Skittles	Headcount	149	201	183	180	186	183	174	157	160	174
WACO	Skittles	Line Assets	55.3	54.4	54.6	52.8	65.5	65.6	66.6	68.1	67.5	69.6
WACO												
WACO												
WACO	Chocolate plant	Volume	30.5	28.2	27.7	29.8	33.4	29.2	33.3	33.8	34.4	32.1
WACO	Chocolate plant	SOC		29.9	44.7	40.9	41.6	42.4	44.8	43.6	47.9	48
WACO	Chocolate plant	Headcount	54	51	44	48	47	54	43	42	34	40
WACO	Chocolate plant	Line Assets	13.9	15.2	8	9.2	11.6	12.1	14.2	12.5	12	14.2

APPENDIX B

PAYROLL DATA

Table B.1 Sample From Chicago Data

CHICAGO PLANT									
NONEXEMPT ASSOCIATES									
1993		1994		2000		2001		2005	
Associate #	Hourly pay	Associate #	Hourly pay	Associate #	Hourly pay	Associate #	Hourly pay	Associate #	Hourly pay
40049604	31.50	40049604	31.50	40049604	31.50	40049604	31.50	40049604	33.86
40048965	19.17	40049128	30.80	40049008	23.93	40049137	24.29	40039538	26.11
40049436	19.05	40049479	30.80	40049364	23.93	40049364	24.29	40048560	26.11
40048728	18.14	40048728	20.22	40049410	23.93	40049410	24.29	40049032	26.11
40049071	18.14	40049266	19.54	40049137	22.79	40048638	23.13	40049137	26.11
40049097	18.14	40049410	19.54	40049176	22.79	40049020	23.13	40049176	26.11
40049123	18.14	40049071	19.25	40049230	22.79	40049129	23.13	40049179	26.11
40049230	18.14	40049097	19.25	40049348	22.79	40049176	23.13	40049364	26.11
40049266	18.14	40049123	19.25	40049423	22.79	40049230	23.13	40049383	26.11
40049303	18.14	40049230	19.25	40049429	22.79	40049348	23.13	40049414	26.11
40049410	18.14	40049303	19.25	40049460	22.79	40049383	23.13	40049460	26.11
40049423	18.14	40049423	19.25	40049525	22.79	40049414	23.13	40049464	26.11
40049613	18.14	40049613	19.25	40049232	22.55	40049429	23.13	40049483	26.11
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.								
Count	462	Count	489	Count	386	Count	418	Count	448
Average	13.69	Average	14.74	Average	18.87	Average	18.88	Average	20.33

APPENDIX C

ALTERNATIVE TEST WITH

TEN YEARS OF DATA

C1 -Testing the Wage Premiums

In this alternative test all 10 years of production data will be used. In order to match the 10 years of production data, estimates will be needed for 6 years of payroll premiums. The premium data for 1993, 1994, 2000 and 2001 are obtained from the BLS and the Mars payroll system. The data for 1995-1999 and 2002 are straight lined between the observed data points. All four production models are run with this data. The models are assessed in the same two ways as in Chapter 3 where the test relies only on observed data. The first is for overall enhancement: Does the model including wage premiums have better accuracy and fit? The second is for individual assessment of the premium itself: Does the coefficient of the premium make logical sense and is it statistically significant? These two assessments will allow us to conclude that wage premiums do or do not help us explain production output.

The production models fit in Chapter 3 using the full 10-year fitting will be used as the base models. All models will be run in logarithmic format and fixed effects will utilized. Wage premium is included as a percentage above the base wage.

C1.1 Cobb-Douglas Test

The base model covering the 10 years of data has an *R* squared of 90% and an overall *F* test of 80.03. The calculated coefficients and significance are shown in Table C.1. The model run with three factor inputs including wage premium is structured as follows:

$\text{Ln (Volume)} = \text{Ln(technology)} + \alpha\text{Ln(Capital)} + \beta\text{Ln(Labor)} + \mu\text{Ln(Wage Premium)} + \varepsilon$

or in traditional form Output = Volume = $tK^{\alpha}L^{\beta}P^{\mu}\ \varepsilon$

Table C.1 Cobb-Douglas 10-Year Base

	Coefficient	*t* statistic
Capital	.698	8.15
Labor	.458	9.04

It has the following results:

The model including wage premium has an *R* squared of 91% and an overall *F* test of 54.75. The calculated coefficients and significance are shown in Table C.2.

From an overall perspective the model is not improved. The slight increase in *R* squared is explained by the added variable and the reduction in the overall *F* test shows that there is a higher chance that the model is not significant.

However from the individual assessment of the premium we learn that most. The negative coefficient is counter intuitive. It implies that as wage premium increases then output declines. The coefficient is also not significantly different from zero.

Using the 10 years of extrapolated data with the Cobb-Douglas comparison we cannot conclude that wage premiums significantly influence output levels as the efficiency wage theory proposes.

Table C.2 Cobb-Douglas 10-Year Wage Test

	Coefficient	*t* statistic
Capital	.767	8.07
Labor	.435	8.33
Premium	-1.739	.386

C1.2 Additive Model Test

The additive model assumes that factor inputs are perfect substitutes. In the efficiency wage model which we are testing wage premiums are not a substitute for labor. Instead they enhance the labor and encourage additional effort. Rather than adding on wage premiums as a separate independent variable, labor will be multiplied by the wage premium percent. This will show a labor amplified by wage premium as the substitute for capital. This model augmented to include wage premiums is as follows:

Ln(Volume) = Ln(Constant + αCapital + β(Labor*Wage Premium))

The base for the additive model run on the 10 years of data results in:

An adjusted *R* squared of 99.3% and a residual deviation of 36.5. The resulting coefficients are as shown in Table C.3.

After including the premium wages the model results in:

An adjusted *R* squared of 99.2% and a residual deviation of 48.33. The resulting coefficients are shown in C.4.

Table C.3 Additive 10-Year Base

	Coefficient	*t* Statistic
Constant	-2.896	6.47
Capital	.669	25.4
Labor	.0204	4.3

Table C.4 Additive 10-Year Wage Test

	Coefficient	*t* Statistic
Constant	-3.175	-5.91
Capital	.705	26.9
Labor	.025	.01

From an overall perspective the model is not improved, with slight negative adjustments to the residual deviation and the adjusted *R* squared. And while there is no specific coefficient for premium wage the coefficient for headcount (which now includes premium wage impact) is smaller and less significant.

Using the Additive model comparison with the 10 years of extrapolated wage premium data we cannot conclude that wage premiums significantly influence output levels as the efficiency wage theory proposes.

C1.3 Translog Test

The translog model is a more complicated model with squared terms and cross products. To include wage premiums will require a three-factor model which is expressed as follows:

$$Ln(Volume) = Constant + B_1Ln(Capital)+B_2Ln(Labor)+ B_3\,Ln(Wage\ Premium) +B_4Ln^2(Capital) + B_5Ln^{2(}Labor) + B_6Ln^{2(}Wage\ Premium)+B_7Ln(Capita)l\times Ln(Labor) +B_8Ln(Capita)l\times Ln(Wage\ Premium)+B_9Ln(Labor)l\times Ln(Wage\ Premium)$$

The base model, run as before but with only the 4 years of data results in the following:

An overall *R* squared of 91.9% and an overall *F* Test of 43.88. The resulting coefficients are as shown in Table C.5.

After including the 10 years of premium wages the model results in:

An overall *R* squared of 91.7% and an overall *F* Test of 24.7. The resulting coefficients are as shown in Table C.6.

Table C.5 Translog 10-Year Base

	Coefficient	*t* Statistic
Log Capital	1.669	4.16
Log Labor	-.5378	2.95
Log Capital squared	.0227	.38
Log Headcount squared	.206	4.95
Log Cross product	-.233	2.83
Constant	-1.247	2.05

Table C.6 Translog 10-Year Wage Test

	Coefficient	*t* Statistic
Log Labor	-.546	-2.7
Log Wage premium	.856	1.42
Log Capital	1.63	3.85
Log Labor squared	.193	4.53
Log Wage premium squared	.114	.69
Log Capital squared	.005	.07
Log Capital X Labor	-.21	-2.48
Log Capital X Wage Premium	-.076	-.92
Labor X Wage Premium	-.066	-.59
Constant	-.719	-.96

From an overall perspective the model is not improved, with slight negative adjustments to the *R* squared and the overall *F* Test. And while there is no single coefficient for premium wage, the coefficients are all now less statistically significant. None of the 4 coefficients which include wage premium are significant. An *F* test on the four coefficients which contain wage premium together gives $F\,(22,167) = 9.75$ which is significant but its significance can be attributed to labor and capital which are significant in both equations. As a result we conclude that there is no increased statistical significance by adding wage premium into the equation.

Using the Translog model comparison we cannot conclude that wage premiums significantly influence output levels as the efficiency wage theory proposes.

C1.4 Constant Elasticity of Substitution Test

The Constant Elasticity model also requires a slightly different form with three-factor inputs. The model including wage premium is expressed as follows:

$$\ln(\text{volume}) = \ln(B0) + \frac{B3}{B2} * \ln\left(B1 * K^{B2} + B4 * WP^{B2} + (1 - B1 - B4) * L^{B2}\right)$$

The base model, formatted as previously derived with the ten years of data results in the following:

An adjusted *R* squared of 99.55% and a residual deviation of -62.84. The calculated coefficients and statistical significance are as shown in Table C.7.

After including the premium wages from the 10 years including the extrapolated data the model results in: An adjusted *R* squared of 99.55% and a residual deviation of -63.79. The calculated coefficients and statistical significance are as shown in Table C.8.

The models result in almost identical *R* squared and residual deviations.

Table C.7 CES 10-Year Base

	Coefficient	*t* Statistic
Adjustor	1.32	4.91
Scale	.1518	18.25
Weight to capital	.912	32.24
Rho	1.15	4.95

Table C.8 CES 10-Year Wage Test

	Coefficient	*t* Statistic
Adjustor	-9.03	6.72
Scale	1.209	5.34
Weight to capital	368	Na
Rho	1.29	3.16

However, the model does not fully solve and some of the coefficients do not make sense. The original model was solved with only six iterations, but the model augmented with the wage premiums took 1173 iterations and could not calculate a *t* statistic for capital weight. Even then the weighting on capital was an unreasonable 368% and the weighting on headcount was 37% resulting in a weighting on wage premium of *negative* 404%. The weighting coefficients are not reasonable and if they were they would imply that wage premium had a negative impact on production which is counter to the assumptions of efficiency wage.

Using the CES model comparison we cannot conclude that wage premiums significantly influence output levels as the efficiency wage theory proposes.

C2 Test Conclusion

This alternative test using the extrapolated 10 years of data results in the same conclusions as the test in the body of the research. Given the consistent results across all four models we are forced to rely as much on the preponderance of evidence as on the depth of a more satisfying individual test. The conclusion of the tests is that this specific data sample does not provide any support for the idea that premium wages increase effort which increases output.

APPENDIX D

CHOOSING A PRODUCTION FUNCTION

The standard assumptions[6] underlying neoclassical production theory are not underlying universal hypothesis and place few limits on the form of mathematical expression of the production function. This leaves us with endless possibilities of the possible function y=F(X1,X2,..) permitted within the theory.

Several of the more popular production functions would include:

1. A Cobb-Douglas form: $Y = aK^{\alpha}L^{\beta}$ as a two input form with capital and labor. Additional inputs are sometimes added on such as human capital. Usually "a" is representative of technology changes which impacts output as a scaled factor of the inputs. In the classical Cobb-Douglas form the exponents add to one which insures that the equation has constant returns to scale. But other structures are also possible including diminishing and increasing returns to scale. A key feature of this mathematical form is that the inputs can function both as partial complements and substitutes.

2. Leontief form: This form is usually shown as $Y = \min(\alpha K, \beta L \ldots)$. This form will allow a different production output impact for the various inputs, however an increase in one input will not impact output unless it is the constraining input. The resulting production function will have one slope based on α/β over the entire length of outputs.

3. Additive form: This form is usually shown as $Y = \alpha K + \beta L \ldots$ This simple form implies that the inputs are perfect substitutes.

4. Translog production function $Ln\ Y = \Theta_o + \beta_K Ln\ K + \beta_L Ln\ L + \beta_M Ln\ M + ½\ \beta_{KK} Ln\ K_2 + \beta_{KL} Ln\ K\ Ln\ L + \beta_{KM} Ln\ K\ Ln\ M + ½\ \beta_{LL} Ln\ L_2 + \beta_{LM} Ln\ L\ Ln\ M + ½\ \beta_{MM} Ln$

[6] Per Chambers (*Applied Production Analysis*, Cambridge England: Cambridge University Press 1988) these would include: Non-negative and real inputs, single values for all possible combinations of inputs, everywhere continuous and twice differentiable, and subject to the law of diminishing returns.

M_2. This function has the benefits of being flexible. It has linear and quadratic terms. It can also be approximated by a Taylor series (Khalili, 1999).

5. Constant elasticity production function. $Y= A(\alpha K^{\gamma}+(1-\alpha)L^{\gamma})^{(1/\gamma)}$

This form has the benefit of being able to accept a variety of amounts for the elasticity of substitution between the inputs. The Cobb-Douglas form limits the elasticity of substitution to a constant of 1.

Finding the appropriate mathematical model can be based on theoretical constricts or on empirical econometric fitting. The appropriate theoretical constricts can be identified between the production functions by looking at among other features the following elements:

Variability in input proportions: Can the firm reach as certain level of output with various selections of input or will a specific input set be required to achieve Y'? Also does the mix required of various inputs change as output changes or is the proportion fixed? This production function features will help in selecting which mathematical form is consistent with the production technology.

Return to Scale: if a form will have constant returns to scale if it is linear, or the sum of exponents equals 1. If the highest order term included for all inputs is second (squared) then the form can have increasing or decreasing returns to scale (but not both) based on whether the sign of the term is positive or negative. If any function will produce increasing, decreasing and constant returns across the possible range of outputs then there must be at least a third-order term on one of the inputs (Furman, 2002).

Identification of inputs as substitutes and complements: Perfect substitutes are reflected in the Addative mathematical form. Perfect complements are reflected in the

Leontief form. The other functions reflect inputs that are partial complements or substitutes.

Changes in Technology: Does a change in technology simply shift the shape of the production function up and down or does it twist and bend the surface shape? A twisting and bending of the surface shape will have the effect of using one factor of production more or less intensively in relationship to the others. This characteristic of the production process will help direct the selection of the mathematical model.

Given the characteristics identified for the production process the mathematical properties of a production function can be specified. These can then be matched with some of the common models as is shown in Table D.1.

Table D.1

	Variability of input	Returns to Scale	Substitute/Complement nature of inputs.	Impact of Technology
Cobb-Douglas	Variable	Single	Partial	Multiplicative
Leontief	Fix	Constant	Complements	Step Function
Additive	Variable	Constant	Substitutes	Additive
Translog	Variable	Multiple	Partial	Exponential
Constant Elasticity	Variable	Single	Partial	Multiplicative

APPENDIX E

A WIDE RANGE FOR EFFICIENCY WAGE?

A resultant condition of the efficiency wage hypothesis that has not been discussed is that it can support both a high road and a low road alternative to profit maximization. It is important to remember that accepting the efficiency wage hypothesis does not necessarily require payment of wages at the high end of the efficiency curve. The actual profit maximizing wage will depend on the shape of the effort curve with respect to wage and the shape of the output curve with respect to effort.

The generally assumed shape for the effort curve is an S shaped curve (Stiglitz J. , 1976). At the low end of wage, little effort is expended. As wages increase E' >0 and effort increases rapidly in response to premium wages. However a point is reached where E''<0. Here either the income effect of the high wage takes over, or the ability of the worker to increase effort diminishes. Eventually effort is either flat or declines. These relationships are shown in Figure E.1 and E.2.

The Output shape resulting from the effort will have a similar curve as long as the relationship is monotonic, i.e., additional effort results in some increased output $\frac{dO}{dE} > 1$. However, there is no reason to expect that this derivative will be constant. As such the

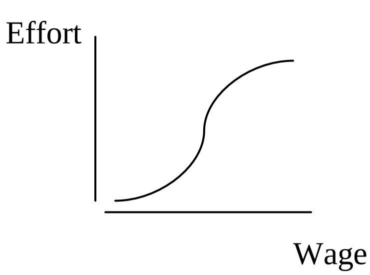


Figure E.1 Wage to Effort

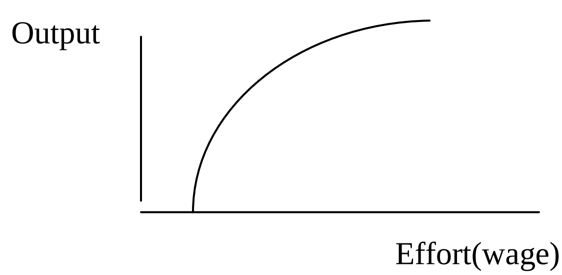


Figure E.2 Effort to Output

particular shape will depend on the output function itself and will likely differ from the Effort wage shape. Profit will be a function of output, the revenue per output and wages as such:

$\pi = R \cdot f\big(E(w)\big) - w$ (assuming that the number of employees is held constant at 1 for simplification)

Given the above shapes for effort and output, this profit function will have the shape shown in Figure E.3.

This shape shows that the profit can be maximized by choosing the appropriate wage, which is the thrust of the efficiency wage hypothesis. However, given that effort's response to wage becomes flat and given the outputs response to effort becomes flat, it is very possible that the shape could also become very flat as is shown in Figure E.4.

A profit wage curve with a large flat section offers different opportunities to reach the maximum profit. Point A and point B on the curve both maximize profit, but one offers much higher wages than the other. This justifies a concept of high road, low road application of the efficiency wage hypothesis.

Usually the concept of high road low road is thought of as relating to cheap wage, unskilled labor, cheap product, versus high wages, skilled labor, superior product, but the

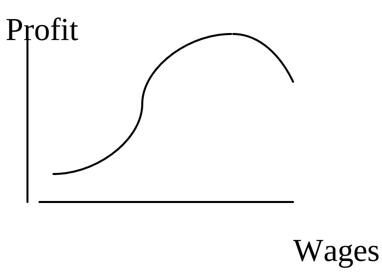


Figure E.3 Wages to Profit

assumptions above provide for identically valued output, and the same technological choice of labor-capital processes but still allow a firm a choice among wage rates in the production process.

With a curve shaped as in Figure E.3, a firm must figure out exactly what wage will provide the effort to produce the maximum profit. While possible in the world of assumptions, in the real world this requires unavailable and unknowable information. And experimentation with different wages over years would require that the relationships were static rather than dynamic. What is much more understandable is a curve such as that in Figure E.4 where there is a large flat section. This can be argued for on the basis of the curves' asymptotic properties. Because the effort relative to wage will become flat, and because output relative to effort will become flat, while both can still have some monotonic, however small , increasing relationship the profit to wage curve could have a large flat section where profit is maximized. This could easily justify different wages by different firms, both trying to maximize their profit.

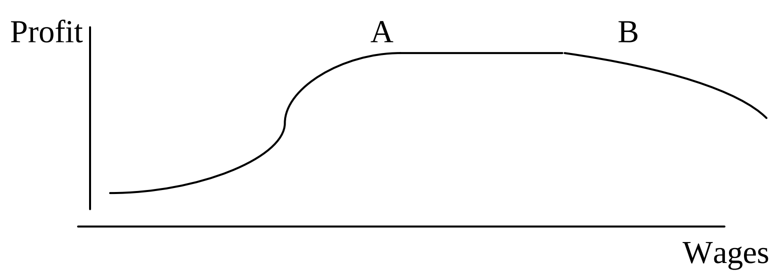


Figure E.4 A Flat Wage Profit Relationship

REFERENCES

Abowd, J., Kramarz, F., & Margolis, D. (1999). High wage workers and high wage Firms. *Econometrica*, *67*(2), 251-333.

Adams, J. (1965). Inequity in social exchanges. In L. Berkowitz, *Advances in experimental social psychology* (pp. 267-300). New York: Academic Press.

Akerlof, G. (1982). Labor contracts as partial gift exchanges. *Quarterly Journal of Economics, 97*(4), 543.

Akerlof, G., & Yellen, J. (1986). *Efficiency wage models of the labor market.* Cambridge: Cambridge University Press.

Bairam, E. (1998). *Production cost functions.* Brookfield Vt: Ashgate Publishing.

Bandiera, B. R. (2009). Social connections and incentives in the workplace: Evidence from personnel data. *Econometrica, 77*(4) , 1047-1094.

Bandura, A. (1997). *Self efficacy. the exercise of control.* New York: Freeman.

Benabou, R., & Triole, J. (2003). Intrinsic and extrinsic motivation. *Review of Economic Studies,77,* 489-520.

Bertell, O. (1971). *Alienation: Marx's concept of man in capitalist society.* London: Cambridge University Press.

Bigelow, G. (2008). *Ernest Mandel's: Marx's theory of wages in the communist manfiesto*. Retrieved Feb 19, 2010, from Economic Systems: http://www.bu.edu/econ/faculty/kyn/newweb/economic_systems/Theory/Marxism/Classics/about_marxism_mandel_lg.htm

Blanchflower, D. (1999). Changes over time in union relative wage effects in Great Britain and the United States. In D.S. Daniel, *The history and practice of economics* (pp.3-32). London: Edward Elgar Publishing.

Bliss, C., & Stern, N. H. (1978). Productivity wages and nutrition, *Journal of Development Economic, 5*(4)*, 331-398.*

Booth, A., & Bryan, M. (2004). The union membership wage premium puzzle. *Industrial and Labor Relations Review, 57*(3) , 402-421.

Bratsberg, B., & Ragan, J. (2002). Changes in union wage premiums by industry. *Industrial Labor Relations 56*(1), 65-83.

Bureau of Labor Statistics. (May 2008). *National compensation survey.* Washington DC: US Government.

Bureau of Labor Statistics. (1991-2003). *Area wage survey.* Washington DC: US Government.

Bureau of Labor Statistics, (various). *Metro area cross industry.* Retrieved May 2010, from BLS.gov archived data: www.bls.gov

Bureau of Labor Statistics. (1991-2002). *Occupational compensation survey.* Washington DC: US Government.

Busha, C. H., & Harter, S. P. (1980). *Research methods in librarianship.* Orlando, Fl: Academic Press, Inc.

Cahuc, P., & Zylberberg, A. (2004). *Labor economics.* Cambridge: The MIT Press.

Campbell, C. I., & Kamlani, K. (1997). The reasons for wage rigidity; evidence from a survey of firms. *The Quarterly Journal of Economics, 112*(3), 759-789.

Chambers. (1988). *Applied production analysis.* Cambridge England: Cambridge University Press.

Clawson, D., & Clawson, M. A. (1999). What has happened to the US labor movement? *Annual Review of Sociology 25*, 95-119.

Cochran, W. (1977). *Sampling techniques.* New York: John Wiley & Sons.

Cui, W. W. (2003). Reducing error in mail surveys. *Practical Assessment, Research & Evaluation 8*(18) , ISSN 1531-7714.

Deci, E. (1975). *Intrinsic motivation.* New York: Plenum.

Deci, E., Koestner, R., & Ryan, R. (1999). A meta-analytic review of experiments examing the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletins 126*(6), 627-668.

Dickens, L., & Katz, F. (1987). *Industry wage differences and industry characteristics.* National Bureau of Economic Research Working Paper 2014.

Dickens, L. (1987). Where have all the good jobs gone. In L. Lang, *Unemployment and the structure of labor markets* (p. 95). New York: Basil Blackwell.

Dillman, D. (1991). The design and administration of a mail survey. *Annual Review of Sociology 17* , 225-249.

Edgeworth, F. (1881). *Mathematical psychics.* Google Books, books.google.com.

Friedman, M. (1970, Sept 13). The social responsibility of a business is to increase its profits. *New York Times Magazine*.

Furman. (2002). *Production in the long run*. Retrieved Nov 2009, from Standford Faculty: http://facweb.furman.edu/~standford.mecon.c4.htm

Green, W. (2010, May 10). *Ph.D. Econometric class notes.* Retrieved May 10, 2010, from Econometric analysis of panel data class notes: http://pages.stern.nyu.edu/~wgreene/Econometrics/PanelDataNotes.htm

Guttschalk, P., & Smeeding, T. (1997). Cross-national differences in the rise in earning inequality. *Review of Economics and Statistics, 80*, 489-502.

Hall, S. T. (1995). The overjustification effect. *Applied Cognitive Psychology*, *9*, 365-404.

Herzberg, F. (2003). One more time, how do you motivate employees? *Harvard Business Review - January* .

Herzberg, F., Mausner, B., & Snyderman.B. (1959). *Motivation to work.* New York: John Wiley.

Iacocca, L. (1986). *An autobiography.* New York: Random House

Judge, S. R. (2009). *Organizational behavior.* Upper Saddle River, NJ: Pearson Education Inc.

Kerr, C. (1977). *Labor markets and wage determination.* Berkeley: University of California Press.

Khalili, A. (1999). *A cross section extimate of translog production functions.* Retrieved 2010, *from Al-Ahilyya Anman University Jordan: www.luc.edu/org*s/meea/volume7/Khalil.pdf

Komaki, J., Coombs, T., & Schepman, S. (1996). Motivational implications of reinforcement theory. In L. P. R. Steers, *Motivation and work behavior* (pp. 87-107). New York: McGraw-Hill.

Kranton, R. (1996). Reciprocal exchange: A self-sustaining system. *The American Economic Review, 86*(4), 830-851.

Kruger, A., & Summers, L. (1988). Efficiency wages and inter-industry wage structure, *Econometrica, 56*(2), 259-293.

Kwoka, J. (1983). Monopoly plant and union effects on worker wages. *Industrial and Labor Relations Review, 36* , 251-257.

Lal, D. (1979). Theories of industrial wage structure. *Indian Journal of Industrial Relations*, *15*(2), 167-195.

Laycock, H. (1999). Explotation via labor power in Marx. *Journal of Ethics, 3*, 121-131.

Leibenstein, H. (1957). The theory of underemployment in backward economies, *The Journal of Political Economy, 65*(2), 91-103.

Leonard, J. (1987). Carrots, and sticks: Pay, supervision, and turnover. *Journal of Labor Economics, 5*(4), S136-S152.

Leonard, K. L. (1987). *Unemployment and the structure of labor markets.* New York, NY: Basil Blackwell Inc.

Malcomson, J. (1981). Unemployment and the efficiency wage hypothesis. *Economic Journal*, *91*, 848-866.

Mankiw, N. G. (2009). *Macroeconomics.* New York: Worth Publishers.

Mars, Incorporated. (2005). *Mars champions sweet success: A special edition.* McLean: Mars, Incorporated.

Mars, Incorporated. (1983). *Mars five principles*. Retrieved Jan 2011, from Mars, Inc.: www.mars.com

Marx, K. (1844). *Economic and philosophic manuscript.* London: www.marxist.org/archive/marx/works/1844/manuscripts/wages.html.

Marx, K. (1891). *Theory of wages quoting -pamphlet Neue Rheinische Zietung*. Retrieved Feb 19, 2010, from Economic Theories : www.economictheories.org/2008/12/karl-marx-theory-of-wages.html

Marx, K. (1848). Communist manifesto. *Selected works volume one* (p 98). Moscow: Progress Publisher

Maslow, A. (1954). *Motivation and personality.* New York: Harpers & Row.

Mitchell, T. (1997). Matching motivational strategies with organizational contexts. In L.L. Cummings, *Research in organizational behavior, 19* (pp. 60-62). Greenwich, CT: JAI Press.

Moscarini, G., & Thomsson, K. (2007). Occupational and job mobility in the US. *The Scandinavian Journal of Economics,109*(4), 807-836.

Mos-Colell, A., Whinston, M., & Green, J. (1995). *Microeconomic theory*. Oxford: Oxford Press.

Nash, J. (1951). Non-cooperative games. *The Annals of Mathematics, Second Series, 54*(2) , 286-295.

Ohingra, O. P. (1969). Managerial strategies of a non-union corporation. *Indian Journal of Industrial Relations, 5*(2), 159.

Peers, I. (1996). *Statistical analysis for education and psychology researchers.* Bristol, PA: Falmer Press.

Pontusson, J., Rueda, D., & Way, C. (2002). Comparative political economy of wage distribution. *British Journal of Political Science*, *32*(2), 281-308.

Raff, D., & Summers, L. (1987). Did Henry Ford pay efficiency wages? *Journal of Labor Economics*, *5*(4), S57-S86.

Reich, G. E. (1973). Dual labor market: A theory of labor market segmentation. *American Economic Review, 63*(2), 359-365.

Roussel, J. I. (Dec 1999). A study of the relationships between compensation package, work motivation and job satisfaction. *Journal of Organizational Behavior, 20*(7),1003-1025.

Rubinstein, A. (1982). Perfect equilibrium in a bargaining model. *Econometrica, 50*(1), 97-109.

Salop, S. (1979). A model of the natural rate of unemployment. *American Economic Review*, *69*(1), 117-125.

ScarLett. (2008). *Karl Marx -Theory of wages*. Retrieved Feb 19, 2010, from Scarlett History of Economic Theory and Thought: www.economictheories.org/2008/12/karl-marx-theory-of-wages.html

Smith, A. (1981 (1776)). *Wealth of nations.* Indianapolis: Liberty Classics.

Solow, R. (1979). Another possible source of wage stickiness. *Journal of Macroeconomics*,*1*(1), 79-82.

Stahl, I. (1973). Bargaining as a decision process. *The Swedish Journal of Economics, 75*(4), 406-409.

Stiglitz, J. (1976). The efficiency wage hypothesis, surplus labour, and the distribution of income. *Oxford Economic Papers New Series, 28*(2), 185-207.

Stiglitz, J., & Shapiro, C. (1984). Equilibrium unemployment as a worker discipline device. *American Economic Review, 74*(3), 433-44.

Uusitab, R. (2002). Changes in the Finnish wage structure, will supply and demand do? *The Scandinavian Jouranl of Economics, 104*(1), 69-85.

Varian. (1992). *Microeconomic analysis.* New York: W.W. Norton & Co.

Veblen, T. (2002). *Bohm−Bawerk's definition of capital and the source of wages.* Retrieved Jan 20, 2010, from Munseys: www.munseys.com

Vroom, V. (1964). *Work and motivation.* New York: Wiley.

Weins, E. (2010). *Eqwald web-services Lt*. Retrieved May 15, 2010, from http://eqwald.ca/economics/translogproduction.pip

Weiss, A. (1990). *Efficiency wages, models of unemployment, layoffs and wage dispersion.* Princeton, NJ: Princeton University Press.

Wilson, K. (2009). *Business forecasting.* Boston: McGraw-Hill Irwin.

Wooldridge, J. (2009). *Introductory econometrics.* Mason, OH: Cengage Learning.